Upper Stillwater River Assessment

Prepared by:
Warren Kellogg
Stream & Watershed Consulting
38 Hidden Valley Drive, Clancy, MT 59634
March 2014

Upper Stillwater River Assessment

Prepared for the:

Stillwater Valley Watershed Council
and
Stillwater Conservation District

March 2014

By:
Warren Kellogg
Stream & Watershed Consulting
38 Hidden Valley Drive, Clancy, MT 59634

Table of Contents

1. Introduction

The Stillwater Valley Watershed Council (SVWC) is a volunteer group of local residents who are working together to enhance the quality of their rural Montana lifestyle by protecting, restoring and conserving their abundant natural resources through good stewardship and community involvement for this and future generations.

They are committed to the following mission:

> *We will provide an open forum in which all interested parties may work in a collaborative effort to sustain our rural quality of life and protect and enhance our natural resources. We are committed to research and educating our valley residents and the public about our Watershed and the steps we can take to preserve and maintain the integrity of the river, the land and the beauty of our valley. We will endeavor to bring together public, private and government resources, funding, and grants to achieve our goals.*

1.1 Purpose of the Assessment

As part of their mission, the SVWC initiated a comprehensive assessment of the major streams in the upper watershed. These streams include the upper Stillwater River (30.3 miles), the West Fork of the Stillwater River (6.2 miles), Lodgepole Creek (4.7 miles), Limestone Creek (2.5 miles), and Little Rocky Creek (2.3 miles). The primary objectives for the assessment were to:

- Compile and summarize all pertinent resource data and information that will complement and direct the field assessment.
- Collect and summarize resource information with special attention given to irrigation infrastructure, riparian area restoration, and to note noxious weed infestations.
- Provide conceptual recommendations and prioritization of restoration opportunities. The recommendations are the precursor to a detailed alternative analysis and cost estimate for individual projects.

1.2 Acknowledgements

The members of the Stillwater Valley Watershed Council and the Stillwater Conservation District are to be commended for their investment of time and interest in providing the leadership and direction for conducting this assessment. The people listed below not only dedicated their time in helping complete this project, but their hospitality and friendship made it a pleasure to work with them.

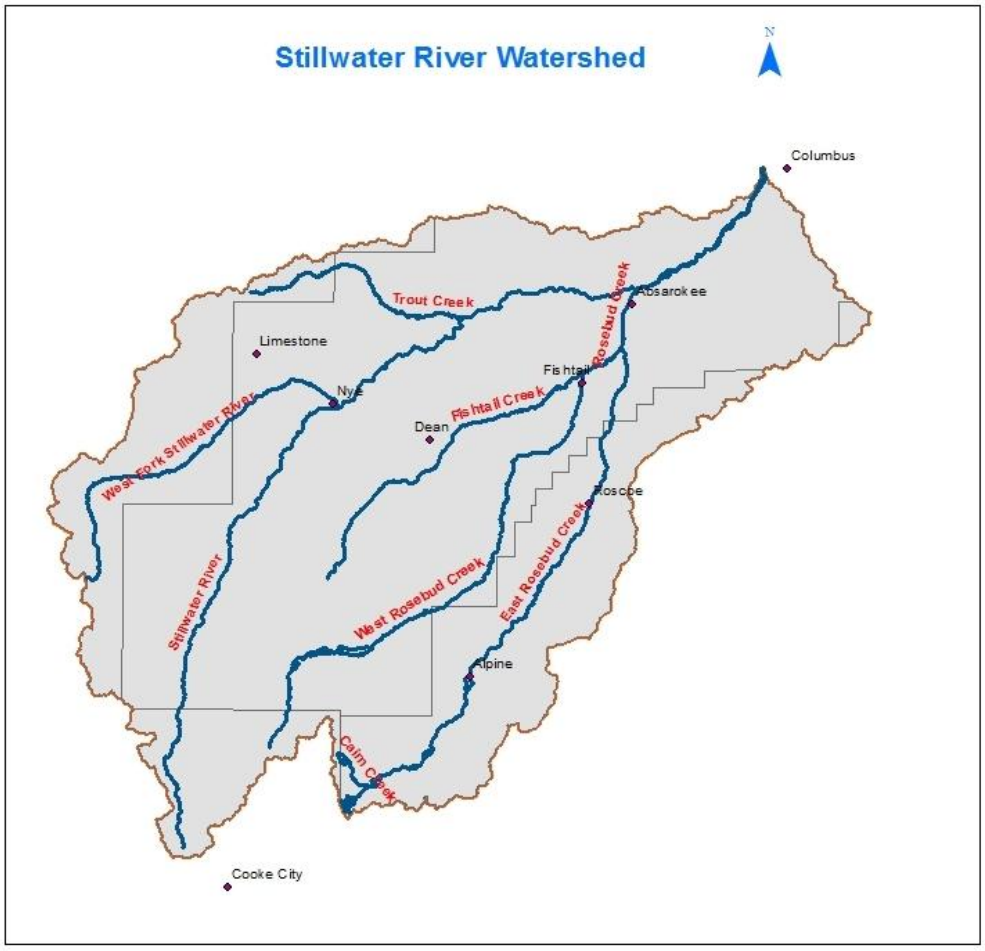
- Theo Yanzick
- Tom Kircher
- Bill Mytton
- Doug Robinette
- Keith Martin
- Lindsey Clark, SVWC Coordinator

Special thanks to Noel Keogh, life-long resident and rancher in the Stillwater Valley Watershed.

2. Background Information

2.1 General Watershed Description

The Stillwater River Watershed comprises approximately 684,000 acres. The river originates in the Absaroka-Beartooth Wilderness south of the Beartooth Mountains in southern Park County, near the state line with Wyoming and the boundary of Yellowstone National Park. It flows for 70 miles, northeast between the Absarokee Range to the west and the Beartooth Mountains to the east, through the Custer National Forest, past Nye and Absarokee, and joins the Yellowstone River just west of Columbus.



This assessment focuses on the upper Stillwater River, West Fork of the Stillwater River, Lodgepole Creek, Limestone Creek and Little Rocky Creek. The stream corridors are primarily in private ownership, interspersed with parcels of State and Federal lands.

Land use in the upper Stillwater River watershed is predominately in livestock production with irrigated hay land in the stream valleys and livestock grazing on upland native range. The Stillwater Mining Company operates a platinum and palladium mine at the head of the valley near the Absaroka-Beartooth Wilderness area boundary.

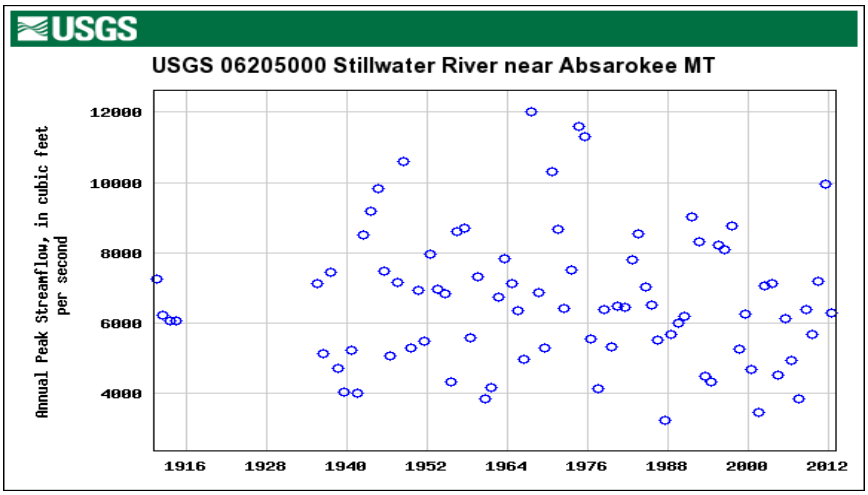
2.2 Hydrology

A limited amount of stream flow data is available for the Stillwater River and its tributaries. There is one active USGS Gage Station on the Stillwater River near Absarokee.

- **Stillwater River near Absarokee (06205000)**

Flow measurements have been recorded from 1910 to the present. Daily water temperatures were collected from 2001 through 2013. The peak flows over the last 104 years are:

- June 3, 1948 – 10,600 cfs (25 year flood event),
- June 15, 1967 – 12,000 cfs (near 100 year flood event),
- June 28, 1970 – 10,300 cfs (near 25 year flood event),
- June 18, 1974 – 11,600 cfs (50 year flood event),
- June 6, 1975 – 11,300 cfs (near 50 year flood event) and
- June 30, 2011 – 9,950 cfs (20 – 25 year flood event).



Several other USGS gage stations were located along the Stillwater River and tributaries that operated for a limited time, but are now inactive. For more information on these stations, access the USGS website at http://waterdata.usgs.gov/mt/nwis/inventory?county

2.3 Brief History

The Stillwater Valley was once part of the Crow Nation and later, in 1868, part of the Crow Reservation. In 1872 the Crow Agency was moved to the Rosebud River, near the town of Absarokee. The agency remained at this site until it was moved in 1884 to its present site at Crow Agency. The Absaroka Mountain Range and the town of Absarokee are namesakes of the Crow People who were also known as the Apsáalooke or Absaroka.

Mining deposits in the upper Stillwater Valley were known to exist since the early 1860's, but it wasn't until 1883 that they were verified. Early prospectors mined ore deposits rich in gold and copper. Today, the Stillwater Mining Company is engaged in the development, extraction, processing, refining and marketing of palladium, platinum and associated metals from a geological formation known as the J-M Reef. It is the only palladium and platinum producer in the United States.

In the late 1800's, life in the upper Stillwater Valley was difficult and lonesome for the predominantly bachelor population of cattlemen and sheep men who settled in the valley. Ranching was challenging with long cold winters, wolves, and dry summers when little hay was produced. The range war between the cattlemen and sheep men found its way into the valley causing altercations and even the death of a sheepherder. Today, some families of the original settlers continue to live in the Stillwater Valley.

There are several stories that tell the origin of the Stillwater River's name. Captain William Clark named the Stillwater River "Rose bud river" on July 19, 1806. In the 1860s, John Bozeman named it Stillwater River because there was a quiet, sandy ford across the river near where it leaves the mountains. The Crow tribe referred to the river as Itch-kep-pe, meaning "Quiet water," derived from a legend about a young man's vain attempt to save his lover from the raging river; both their bodies washed into a quiet pool, which was named in their honor. Eventually, the entire river became known by the name for this quiet pool. Another story claims the river was named by the Indians after they went out to find its source. When they returned, another party asked if they found its source and the Indians answered, "No, still water." Since that time, the river was called the Stillwater. Who's to really say how the Stillwater River came by its name.

2.4 Project Background

The Derby Fire was the catalyst that brought landowners, agency personnel and concerned sportspersons together to organize the Stillwater Valley Watershed Council (SVWC). This council was established when volunteers and other concerned citizens realized that the impacts of the Derby Fire reached beyond the burn zone to include adjacent ranch and public lands. The SVWC eventually expanded from its original goals of noxious weed control to a variety of resource issues that affect the watershed. This has resulted in active participation from government agencies, non-profit organizations and private land owners (both traditional agriculturalists and small tract owners) who have an interest in the Stillwater River and its tributaries.

3. Assessment Methodology

The stream assessment of the Stillwater River (Woodbine Campground to the Johnson Bridge), the West Fork Stillwater River, Lodgepole Creek, Limestone Creek, and Little Rocky Creek was completed on the ground by walking all five streams (46 miles). Specific tasks included:

- compiling and summarizing all pertinent site reports, resource data and information that complement the field assessment;
- collecting and summarizing resource information with special attention given to irrigation infrastructure, channel stability, riparian area restoration, and noxious weed infestations;
- providing conceptual recommendations and prioritization of restoration opportunities.

Fieldwork was completed in July – September of 2013 by Warren Kellogg (Watershed Consulting) under contract with the Stillwater Conservation District and the guidance of the Stillwater Valley Watershed Council. In addition to walking the streams, several landowners were interviewed to obtain a historical perspective of the river and to understand the issues associated with each stream.

The upper Stillwater River Assessment focused on infrastructure condition and functionality, riparian forest sustainability, channel stability, and noxious weed infestations. Observations and restoration recommendations are based upon professional judgment and 35 years experience working on Montana streams.

The 2011 color aerial photography (NAIP – National Agricultural Imagery Program) was used as the base photography for the assessment. Maps (scale 1:10,000) are included in this report. Older aerial photography/maps were also referenced to determine change over time.

Detailed field notes and digital site photos were taken during the field assessment. Each site was documented with GPS coordinates as listed in Appendix A. All sites referenced in the report have been labeled on the maps.

4. Observations and Planning Considerations

4.1 Stillwater River

The Stillwater River assessment began at the US Forest Service (USFS) Woodbine Campground and ended at the Johnson Bridge, 1.7 miles upstream from the mouth of Rosebud Creek. The Stillwater River above Woodbine Campground was not included in this assessment as it lies in a non-motorized wilderness area. The lower 14 miles of the Stillwater River may be included in a future river assessment.

The land use along the upper Stillwater River consists of traditional agriculture and small tract subdivisions. In addition, there is a large underground palladium/platinum mine operation south of Nye. During summer months, the river receives heavy recreational use, primarily from fishing, rafting, and summer tourists. All activities play a significant role in the health of the Stillwater River.

Site SW-1 Stream Crossing – Bridge: USFS Woodbine Campground **Priority: No Action**
(Stillwater River – Map #1)
Concrete bridge with an approximate 125 foot span across the Stillwater River. The bridge is relatively new and in excellent condition.

Site SW-2 Side Channel Dike **Priority: No Action**
(Stillwater River – Map #1)
Small gravel dike in a flood channel on the west side of the river. The dike is old and no longer functional. The original intent of the dike was to prevent high water from accessing additional side channels along the west side of the river.

Site SW-3 Bank Stabilization – Rock Rip-Rap **Priority: Low**
(Stillwater River – Map #1)
Old rock rip-rap flanked by the river is now in the middle of the active channel. The intent of the rip-rap was to protect an irrigated hay field on the east side of the river. The field is no longer irrigated and is currently used as dryland pasture. The rock in the channel is not causing any major problems, although it could pose a safety hazard for floaters.

Old rock rip-rap in the middle of the river.

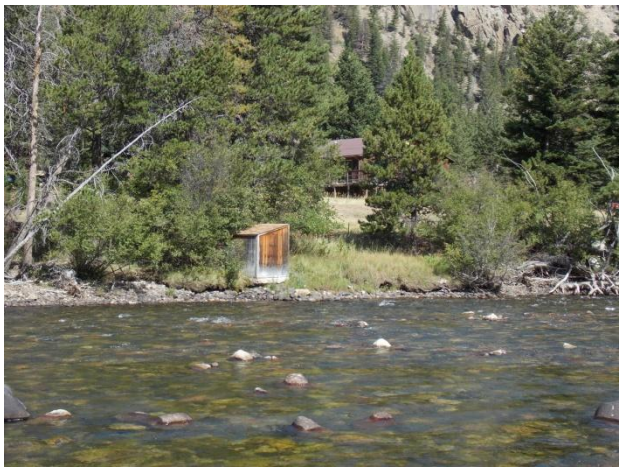
Recommendation: Remove the old rock rip-rap from the middle of the river.

Site SW-4 Pump House – Domestic Use **Priority: Low**

(Stillwater River – Map #1)

Small pump house on the west side of the river. A house is located 200 feet up the bank from the pump house.

The pump house sits just above the low water level. A water mark on the exterior of the pump house indicates a recent high water event. The concrete foundation of the pump house is scouring. Downstream from the pump house, approximately 100 feet of old rock rip-rap lines the bank.



Old pump house on the west side of the river. White stain indicates a high water mark.

Recommendation: Remove the pump house if no longer in use. Relocate it further up the bank if it is still being used.

Site SW-5 Bank Stabilization – Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #1)

Rock rip-rap extends approximately 1,100 feet along the west bank. It was installed to stop the river from eroding into an adjacent pasture. A riparian fence on the upper bank parallels the rip-rap.

The rip-rap was installed in different stages using round cobbles and small boulders (0.5 – 3 foot diameter) along a 5 foot high bank. Some minor scouring of the rip-rap has occurred, but most is still intact and functional. The adjacent river channel is wide and shallow with large mid-channel depositional silt bars created by a downstream geologic restriction.

Site SW-6 Cable Crossing – Non Functional **Priority: No Action**

(Stillwater River – Map #1)

The remains of a steel cable transport system once suspended across the river. A steel post on the west bank and a concrete box on the upper east bank served as anchors. The cable is currently lying along the river's west bank.

On the opposite bank, an old ramp down to the river may have been used as a ford crossing or pump location. A rock jetty (large boulders) was constructed on the downstream side of the ramp.

Site SW-7 Cross-Channel Rock Check Structure **Priority: No Action**

(Stillwater River – Map #1)

Cross-channel rock check structure constructed in the 1940s. The rock check structure is approximately 8 feet high constructed with extremely large boulders. The east side of the structure has a step/pool run that provides fish passage (FWP communication). The purpose for this structure is to maintain a set water level (mill pond) for an upstream pump house. The pump house is used primarily to supply fire water to the Stillwater Mine facilities. Silt periodically needs to be cleaned from the backwater pool next to the pump house. Upstream of the pump house, the river channel appears to have been moved closer to the east bank, perhaps to divert the river's direct current away from the pump house.

Rock rip-rap armors the east bank below the step/pool run. A series of rock weirs lay between Site SW-7 and the downstream bridge (SW-8).

Site SW-8 Stream Crossing – Private Bridge **Priority: No Action**

(Stillwater River – Map #1)

Wood beam bridge (80 foot free span) supported by concrete abutments. The bridge abutments slightly encroach into the river channel. Rock rip-rap protects the west abutment. The bridge serves as Stillwater Mine's primary access to the east side of the river.

Site SW-9 Discharge Pipe **Priority: No Action**

(Stillwater River – Map #2)

Old stormwater discharge pipe (30 inch diameter CMP) on upper west bank. It is no longer used.

Site SW-10 Small Tracts - Whited Subdivision **Priority: High**

(Stillwater River – Map #2)

Subdivision with 12 small tracts along 0.3 miles of the west river bank. The subdivision was developed in the 1960s. Most tracts have houses on or near the river's edge usually with some form of bank stabilization: rock rip-rap, flow deflectors (jetty) and/or floodplain dikes. Small irrigation pumps in the river are used for landscape watering. The riparian vegetation has been cleared to varying degrees to accommodate landscaping.

Individual small tract impacts to channel stability, in-stream flow, and water quality are usually minimal, but cumulatively they pose a significant risk to the Stillwater River.

Small tracts: House on river's edge with bank stabilization and a small irrigation pump.

Recommendation: Develop and implement a small tract outreach and assistance program to help landowners better understand how to minimize their impacts on the river. Program topics would include noxious weed management, water rights, septic maintenance, riparian vegetation, suitable building locations, and basic river dynamics.

Site SW-11 Stream Crossing – Private Bridge **Priority: No Action**
(Stillwater River – Map #2)
Railroad car suspension bridge with concrete abutments. The bridge has a 110 foot span across the river. One bridge/suspension support is located 15 feet from the east abutment. The bridge accesses property and buildings on the southeast side of the river owned by the Stillwater Mine Company.

Reach 1: Sites: SW-1 to SW-11
(Stillwater River – Map #'s 1 & 2)
Channel Characteristics: The river channel is primarily single-threaded, slightly entrenched with a high gradient. It is naturally armored with boulders and cobbles making it resilient to physical disturbance. The overall reach slope averages 1.3%, but ranges as high as 4% along the steep cascading sections and less than 1% slope where the river becomes flat and braided. Bedrock has created "hard points" (vertical grade control) in the river at Sites SW-3 and SW-6. Upstream from these "hard points", the river is wide, braided and shallow. Downstream, it quickly transitions to a steep, step/pool channel.

Major tributaries: Woodbine, Verdigris, Flume, and Nye Creeks.

Single threaded, low sinuosity river channel near Site SW-9.

Riparian Characteristics: The channel type is reflected by the riparian corridor. Where the river channel is wide and braided, the riparian corridor is also wide (up to 1,500 feet between Sites SW-4 and SW-5). Where the river channel is single-threaded and relatively steep, a narrow band of riparian vegetation borders the river bank (30 – 120 feet wide).

Near Woodbine Campground (SW-1), the riparian corridor is dominated by Douglas fir. Black cottonwood and lodgepole pine trees are interspersed with the Douglas fir. Downstream from Site SW-2, black cottonwood becomes more dominant with a mix of conifers (Douglas fir, lodgepole pine, and Ponderosa pine). Thin leaf alder, snowberry, water birch, sandbar willow, and chokecherry are common shrubs in the understory.

Spotted knapweed is thinly scattered along the river and upper benches. A Canada thistle infestation is especially heavy along Site SW-5.

Site SW-12 Steel Pilings **Priority: Medium**

(Stillwater River – Map #2)

Eight steel pilings line the toe of an eroding terrace bank (~ 12 feet high) on the west side of the river. Several pilings are upright; others have fallen into the river. These piling may have been part of a bank stabilization effort or part of an old river crossing. The pilings create a potential safety hazard to floaters.

Steel pilings along the toe of a high terrace.

Recommendation:

1) Remove all the steel pilings from the river channel.

Site SW-13 Terrace Erosion **Priority: Medium**

(Stillwater River – Map #2)

Eroding terrace about 10 — 12 feet high, located 350 feet upstream from Site SW-14. The river has eroded approximately 50 – 70 feet into the terrace since 1963 and is slowly migrating towards Highway 419. Currently, the river is 85 feet away from the highway right-of-way. Erosion will likely continue at a relatively slow pace.

Eroding terrace bank upstream from the Old Nye Fishing Access Site. The river is slowly moving towards Highway 49.

Recommendation: Monitor the migration of the river towards the highway to determine if and when future bank stabilization measures may become necessary.

Site SW-14 Boat Ramp – USFS Old Nye Fishing Access Site **Priority: No Action**

(Stillwater River – Map #2)

Gravel boat ramp at Old Nye Fishing Access Site. The Fishing Access Site and boat ramp were reconstructed in 2012. Immediately downstream from Site SW-14, there is some minor terrace erosion, but it has moved very little over the last 50 years and does not warrant treatment.

Site SW-15 Stream Crossing – Private Bridge **Priority: No Action**

(Stillwater River – Map #2)

Concrete beam bridge with two mid-channel bridge supports (concrete filled CMPs). It has a 140 foot span across the river. Both abutments are faced with rock rip-rap. The west abutment is located where a high water side channel (main channel in 1963) enters the river on the upstream side. The bridge provides access to several small tracts on the east side of the river. Houses associated with these tracts have been built on a terrace bench off-set from the river.

Site SW-16 Bank Stabilization - Rock Rip-Rap **Priority: Low**

(Stillwater River – Map #2)

Rock rip-rap armors 220 feet of the west bank protecting a pasture, golf green and pond on the floodplain. The rip-rap consists mainly of round cobbles and small boulders (1 – 3 feet diameter). The upper end of the rip-rap (~ 60 feet) is intact and functional; the lower 160 feet has scoured and is partially flanked. A mid-channel gravel bar is deflecting the current directly into the bank, increasing pressure on the failed rip-rap. The riparian vegetation along the river has been cleared making this bank vulnerable to accelerated erosion. This bank will probably continue to erode during high water events.

Scoured rock rip-rap on the lower end of Site SW-17. A mid-channel gravel bar deflects the current directly into the bank.

Recommendation:

1) Repair 80 – 100 feet of bank rip-rap where the river current is directly hitting the bank. Plant cottonwood and willow cuttings behind the rip-rap for long-term stability; or
2) Monitor the progress of the bank erosion to determine if and when bank stabilization measures warrant the expense.

Site SW-17 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #2)

Rock rip-rap along 430 feet of the west bank is intact and functional. The rip-rap was installed to prevent loss of property and/or to keep the river from shifting into a side channel. If the river did reactivate this side channel, buildings on the floodplain may be threatened.

1963 aerial imagery shows that the river has migrated west about 100 feet over the last 50 years. The riparian forest is in good condition and may actually have increased in size over the last 50 years.

Site SW-18 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #2)

Rock rip-rap extends approximately 300 feet along the west bank and appears to be intact. The rip-rap consists of small round boulders, 1 – 3 feet in diameter. The rip-rap was installed to protect an adjacent pasture and building located on the floodplain. The bank armoring forces the river to the east terrace contributing to bank erosion downstream (See Site SW-19 narrative).

Site SW-19 Accelerated Bank Erosion **Priority: Medium**

(Stillwater River – Map #2)

Active bank erosion on approximately 200 feet of bank (~ 6 feet high) along a subirrigated hay field on the west side of the river. The bank has eroded nearly 40 feet in the last 15 years, and 100 feet over a 50 year period. A high water side channel on the downstream end of the bank erosion circles to the west. Two factors are contributing to the bank erosion: 1) the upstream rip-rapped river banks (Sites 17, 18, and 19) has restricted the river channel and directed the main current towards this bank and; 2) a large gravel bar has formed on the opposite bank that will continue to build and push the river west. If the bank is allowed to erode into the side channel, the side channel may eventually become the main river channel.

Active bank erosion along a hay field on the west side of the river. Rock rip-rapped banks upstream and a large gravel bar on the opposite bank are contributing to the erosion.

Recommendation: Install approximately 200 feet of rock rip-rap from the mouth of the side channel going upstream. Incorporate a small flow deflector at the downstream end of the rip-rap, just above the mouth of the side channel. Use well-placed angular rock on a 3:1 shaped bank. Keep the side channel open allowing high water access. Plant cottonwood and willow transplants and cuttings behind the rip-rap for long-term stability.

Site SW-20 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #3)

Rock rip-rap on the west side of the river. The rip-rap begins at the outlet of the side channel mentioned in the Site SW-19 description and continues downstream 120 feet along the perimeter of a large eddy. The rip-rap was constructed with large round boulders ranging in size from 1 – 5 feet in diameter. Willow clumps planted on the bank above the rip-rap are dead. They may have been planted too high on the bank with their roots out of the water table.

Between Sites SW-19 and SW-20, channel manipulation occurred in the 1960s. Gravel spoil piles are still evident on the west bank. Over the last 50 years, the river has been slowly migrating east. In last 15 years, the river moved 60 feet towards an old side channel. Currently, 80 feet of riparian vegetation separates the river from the side channel. If the river continues moving at this rate, it may eventually cut into the side channel completely bypassing Site SW-20.

Site SW-21 Bank Stabilization - Rock Rip-Rap & Dike **Priority: No Action**

(Stillwater River – Map #3)

Rock rip-rap and a small dike line 470 feet of the east river bank immediately upstream from a private bridge (SW-22). The rip-rap ranges in size from small cobbles to large round boulders (0.5 – 4 feet diameter). The floodplain dike is 1 – 3 feet higher than the original floodplain elevation.
The purpose for the rip-rap and dike is to prevent the river from flanking the bridge and threatening ranch buildings on the east floodplain.

Site SW-22 Stream Crossing – Private Bridge **Priority: No Action**

(Stillwater River – Map #2)

Steel rail car bridge with two mid-channel bridge supports has a 180 foot span across the river. The concrete abutments and bridge supports are faced with rock rip-rap. Low flows pass under the east third of the bridge. Large gravel bars have formed both upstream and downstream of the west half of the bridge.

Site SW-23 Bank Stabilization - Rock Rip-Rap **Priority: Medium**

(Stillwater River – Map #3)

Downstream from the bridge (SW-22), approximately 170 feet of rock rip-rap lines the west bank. The rip-rap was installed about 15 years ago. It is partially functional and does not extend far enough upstream. Behind the rip-rap, a 70 – 100 foot wide riparian buffer separates the river and hay field.

Rock rip-rap has scoured out and is only partially functional. Additional rock is needed to protect the bank.

Recommendation: The existing rip-rap will need to be reinforced with additional rock (preferably large angular rock) and extended 50 – 60 feet upstream where the main current crosses a diagonal channel bar and directly impacting the west bank.

Site SW-24 Accelerated Bank Erosion **Priority: Medium**

(Stillwater River – Map #3)

Downstream from the SW-23 rock rip-rap, there is approximately 550 feet of active bank erosion. This bank was previously protected by rock rip-rap that has since failed and sloughed off into a deep pool. Since 1963, the river has eroded approximately 70 feet into an adjacent hay field. In the last 15 years, it moved about 20 feet.

The mouth of a flood channel on the north bank is located 800 feet downstream from Site SW-24. A large gravel bar on the opposite bank is pushing the river to the north. Given the current channel pattern, it seems unlikely that the main river will breach into the flood channel anytime soon; however this certainly could change if a large debris jam or ice jam formed at this location. The effects from the large gravel bar are being manifested downstream from the flood channel mouth where 70 feet of river bank and riparian forest have been lost in the last 15 years.

Bank erosion along a hay field on the west side of the river. Previously placed rock rip-rap has sloughed into the channel.

Recommendation:

The eroding bank has not moved appreciably in the last 15 years. Reinstalling rock rip-rap along this length of bank, given the deep channel and long bank, would be expensive and may be premature.

An initial step would be to do a detailed survey of the area to quantify channel migration rates into the floodplain to determine the cost/benefits of installing rip-rap. This survey would document active headcutting and elevation differences between the old channel traces on the west floodplain and the current river channel. Refer to the Reach 2 recommendation where the Site SW-24 survey could be done as part of a larger reach assessment.

Site SW-25 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #3)

About 1,800 feet of rock along the toe of Highway 419 where the road grade follows the river. Most of the rock is poorly placed, but is functioning as intended. Short sections of rip-rap along the upper end have minor scouring around the rocks. A good vegetative buffer has established behind the toe rock leading up to the base of the highway retaining wall.

Site SW-26 Stream Crossing – Private Bridge **Priority: No Action**

(Stillwater River – Map #3)

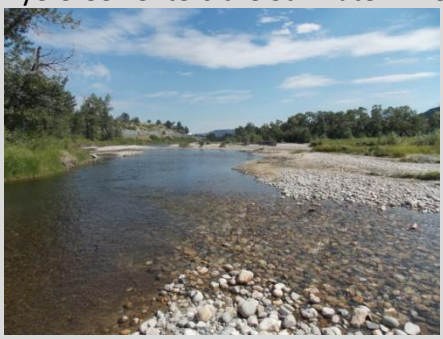
Steel beam bridge (100 foot free span) with concrete abutments and no bridge supports. The abutments are partially faced with rock rip-rap. The north abutment encroaches about 15 feet into the channel creating a slight restriction in the river.

Reach 2: Sites SW-11 to SW-26 **Priority: High**

(Stillwater River – Maps #2 & 3)

Channel Characteristics: This reach quickly transitions to a channel slope (0.3%) that is 50% less that Reach 1. Because of the lower gradient, the river becomes more dynamic with increased sinuosity and multiple side channels. In-channel gravel bars are common along the entire length of the reach. Because of the dynamic nature of the river, several landowners have been compelled to install rock rip-rap to protect property and/or restrict high water access to the historic floodplain. The armoring and restriction of the river has shifted the bank erosion to other unprotected banks.

Nye Creek enters the Stillwater River downstream from Site SW-11.



Large gravel bars are common along Reach 2.
Photo taken near Site SW-24.

Riparian Characteristics: This riparian corridor is wider than Reach 1, ranging from 700 feet to over 1,000 feet. These larger riparian areas are consistent with the dynamic nature of the river as described above. The riparian plant community is dominated by a black cottonwood trees with an understory of thin leaf alder, water birch, yellow willow, snowberry, and chokecherry. Sandbar willow is a pioneer species typically found on the gravel bars.

Spotted knapweed plants are thinly scattered along the river. These weeds are often associated with previously disturbed areas such as rip-rapped banks or bridges.

Recommendation: Complete a detailed assessment of the river from Site SW-15 to SW-26 (2.4 miles) to determine options for mitigating the loss of channel length due to bank armoring and floodplain restrictions.

Site SW-27 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #3)

Approximately 300 feet of rock rip-rap armor the north bank. The upper 50 feet are scattered boulders (1 – 2 feet diameter) placed upstream of a livestock water gap. Below the water gap, there is an additional 250 feet of cobbles/gravel rip-rap along a shaped bank. A riparian fence closely parallels the river on the upper bank.

Site SW-28 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #3)

Round boulders of various sizes have been randomly dumped on 80 feet of the south bank. High flows scour around the rocks causing more bank erosion than if they weren't there. The north end of a landing strip is 35 feet from the river, upstream from Site SW-28. The expensive to repair the rip-rap is not warranted.

Site SW-29 Bank Stabilization - Rock Jetties **Priority: No Action**

(Stillwater River – Map #3)

Two rock jetties on the north bank about 80 feet apart. They were built with large round boulders. The jetties were placed to protect buildings on the adjacent floodplain and are functioning as intended.

Site SW-30 Channel Dike **Priority: No Action**

(Stillwater River – Map #3)

Two sections of an old gravel dike have been pushed up along the north bank. The upper dike is plugging an old river meander that was the main channel in the 1950s. The dikes appear to be old as vegetation is growing up through them. The dikes range in height from 2 – 6 feet and are partially functional. A breach has occurred in the lower dike. Spotted knapweed is abundant at this site.

Site SW-31 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #3)

Two sections of "white" rock rip-rap line the north river bank. 300 feet of rip-rap is separated by 100 feet of unarmored bank. The rip-rap was constructed with 1 – 3 foot diameter round boulders.

Site SW-32 Small Tracts – Hanks Cabin Sites and Borland Subdivision **Priority: High**

(Stillwater River – Map #3)

Two separate subdivisions, consisting of 8 – 10 small tracts, occupy 0.5 miles of the north bank. Most tracts are less than 5 acres and have houses near the river's edge. Some form of bank stabilization (rock rip-rap and/or jetties) is associated with these tracts. They all have small in-river irrigation pumps or shallow wells for landscape watering. The riparian vegetation has been cleared to varying degrees to accommodate landscaping.

Individual small tract impacts to channel stability, in-stream flow, and water quality are usually minimal, but cumulatively they pose a significant risk to the Stillwater River.

Small tracts: house on low floodplain with landscaping to the river's edge.

Recommendation: Develop and implement a small tract outreach and assistance program to help landowners better understand how to minimize their impacts on the river. Program topics would include noxious weed management, water rights, septic maintenance, native riparian vegetation, suitable building locations, and basic river dynamics.

Site SW-33 Stream Crossing – Highway 419 Bridge **Priority: No Action**
(Stillwater River – Map #3)
Concrete bridge with a 160 foot free span across the Stillwater River. The bridge is in excellent condition.
The Buffalo Jump Fishing Access Site (FAS) managed by Montana FWP is located immediately downstream from the bridge on the west side. The FAS is located on an historic floodplain that is seldom inundated by flood water due to the Highway 419 right-of-way.

Site SW-34 Bank Stabilization - Rock Rip-Rap **Priority: No Action**
(Stillwater River – Map #4)
There is 700 feet of cobble rip-rap placed on a 2:1 slope on the west river bank. Approximately 100 feet of rip-rap has washed out on the apex of the bend across from a large gravel bar. A 20 – 60 foot wide riparian buffer separates the rip-rap from the hay field

A large spring enters the Stillwater River on the upstream end of Site SW-34. Riparian forest and wetlands on the west floodplain were cleared and developed into hay fields during the 1960s.

Site SW-35 Small Tracts – Buffalo Jump and Spreading Winge Subdivisions Priority: High
(Stillwater River – Map #4)
There are 35 small tracts in two adjoining subdivisions along 2.2 miles of the river (southeast side). Developed in the 1980s, the tracts vary in size from 5 – 10 acres. Most tracts have houses either set back from the river or built directly on the river's edge. The riverfront houses are usually associated with riparian clearing, bank stabilization (rock rip-rap), and in-river pumps.

Long gravel dikes have restricted high water access to parts of the historic floodplain. These dikes are old and were constructed prior to the land being subdivided. They continue to not only affect the abandoned floodplains, but are indirectly impacting property downstream and across the river.

Individual small tract impacts to channel stability, in-stream flow, and water quality are usually minimal, but cumulatively they pose a significant risk to the Stillwater River.

Riparian vegetation is often cleared on small tracts (left photo). Bank stabilization eventually becomes necessary when the banks are left unprotected. Gravel dikes pushed up along the river's edge prevent high flows from accessing the historic floodplain (right photo).

Recommendation: Develop and implement a small tract outreach and assistance program to help landowners better understand how to minimize their impacts on the river. Program topics would include noxious weed management, water rights, native riparian vegetation, septic maintenance, suitable building locations, and basic river dynamics.

Site SW-36 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #4)

900 feet of cobble rock rip-rap on the west bank of the river next to a hay field. The rip-rap is intact and functional. A 5 – 8 foot grass buffer and riparian fence separate the rip-rap and the hay field.

Downstream from Site SW-36, an old gravel dike was built on the upper bank paralleling the river. It is 1 – 4 feet high and extends about 100 feet. Its purpose was to keep high water out of a short river meander and off the adjacent hay field. The lower end of the dike has since washed out.

Site SW-37 Irrigation Sump/Pump **Priority: No Action**

(Stillwater River – Map #4)

Concrete sump and 45 HP electric pump on the west side of the river. The pump provides water (990 gpm) to two half pivots and a wheel line on about 70 acres of hay fields. The sump has a self-cleaning screen on the inlet. The sump and pump are protected by three rock jetties and 80 feet of rock rip-rap upstream from the pump.

SW-38 Bank Stabilization - Rock Rip-Rap/Jetties/Dikes **Priority: No Action**

(Stillwater River – Map #4)

Immediately downstream from Site SW-37, along 850 feet of the north bank, a series of small boulder jetties and rock rip-rap line the bank. An old boulder/gravel berm (1 – 3 feet high) follows the upper bank. The bank stabilization and berm were intended to keep the river from recapturing an old river channel. Except for the lower end of the rip-rap, these structures are no longer functional.

SW-39 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #4)

Rock rip-rap along the north bank protecting two home sites. The nearest house is 35 feet away from the river. The 400 foot long rip-rap consists of loosely placed large boulders (2 – 4 foot diameter) and flat shelf rock. This bank is along a straight riffle between bends so the shear stress on the bank and rip-rap is low. The 1903 GLO maps show this riffle was once used as a ford crossing.

Upstream from Site SW-39, (different owner), a 270 foot long shaped 3:1 bank is vegetated and stable. It is unknown if there is rip-rap buried beneath the silt.

Little Rocky Creek enters the Stillwater River on the opposite bank.

SW-40 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #4)

Rock rip-rap (140 feet) along the west bank. The rip-rap was constructed with 2 – 3 foot diameter round boulders. It has partially washed out.

The river splits into two channels immediately upstream from Site SW-40. The rip-rap is located on the west channel which runs water only during high flows. When water is flowing down the west channel, a large gravel bar forces the flow into the west bank. Even though the rip-rap has partially failed, the bank has not eroded appreciably over the last 20 years. It would not be worth the investment to repair the rip-rap. Old aerial photography shows the west channel was once the main channel.

Stanley Coulee enters the Stillwater River about 400 feet downstream from Site SW-40.

Site SW-41 Boat Ramp – Montana FWP Moraine Fishing Access Site **Priority: Low**

(Stillwater River – Map #5)

Dirt boat launch at the Moraine Fishing Access Site (60 acres). The boat launch is in poor condition. A gravel bar has formed at the end of the ramp making it difficult to launch rafts.

Dirt boat ramp at the Moraine Fishing Access Site.

Recommendation: Reconstruct the boat launch site to better accommodate recreational use and high water impacts. The boat ramp should be relocated downstream about 250 feet. The Old Nye FAS (Site SW-14) would serve as a good template.

Site SW-42 Old Stream Crossing Abutments **Priority: No Action**

(Stillwater River – Map #5)

Old rock bridge abutments on both sides of the river. The 1951 aerial photography show a bridge at this site. Large boulders in mid-channel may have been used as bridge supports. The bridge may have been used as a sheep bridge as no road traces can be seen near the site. The river may eventually flank the east abutment, although there has been little change over the last 15 years.

Magpie Creek enters the Stillwater River from the southeast between Sites SW-42 and SW-43.

Site SW-43 Old Stream Crossing Abutments **Priority: No Action**

(Stillwater River – Map #5)

Old rock bridge abutments on both sides of the river. The abutments are about 40 feet wide and 10 feet high. There was a bridge crossing at this site sometime between 1901 and 1951, but the type of bridge is unknown.

Site SW-44 Small Tracts – Tractor and Equipment Subdivision **Priority: High**

(Stillwater River – Map #5)

This subdivision included 12 small tracts along 0.9 miles of the northwest side of the river. The land was subdivided in the 1980s and 1990s into tracts that vary in size from 4 – 20 acres. All but two tracts have been developed. Most houses were built on the terrace bench within 100 feet off the river's edge. Their close proximity to the river has compelled several tract owners to install bank stabilization (rock rip-rap and jetties), clear native riparian vegetation and place pumps in the river for landscape irrigation.

Individual small tract impacts to channel stability, in-stream flow, and water quality are usually minimal, but cumulatively they pose a significant risk to the Stillwater River.

Rock jetty on upstream side of landscaped yard.

Recommendation: Develop and implement a small tract outreach and assistance program to help landowners better understand how to minimize their impacts on the river. Program topics would

include noxious weed management, water rights, septic maintenance, riparian vegetation, suitable building locations, and basic river dynamics.

Site SW-45 Irrigation Structure **Priority: No Action**

(Stillwater River – Map #5)

Irrigation headgate on the north side of the river channel. This is the uppermost headgate on the Stillwater River mainstem. The headgate has a concrete headwall with a wood slide gate. The bypass outlet is 10 feet wide and can be checked up with boards during low flows. The concrete is dated Sept 1966. Repairs were made in June 1999. A 250 foot long rock wing diversion (large boulders) extends upstream along the north bank. Rock rip-rap parallels the diversion on the north bank. There is a water control structure about 300 feet down-ditch from the headgate.

The use of large rocks for the wing diversion requires minimal maintenance. Floating debris appears to be a problem during high water although the wide bypass outlet may pass most of it. The structure seems to function well although the concrete is beginning to show signs of wear.

Site SW-46 Boat Ramp – Montana FWP Castle Rock Fishing Access Site **Priority: Low**

(Stillwater River – Map #5)

Dirt boat ramp at the Castle Rock Fishing Access Site (80 acres). The ramp is steep and in need of repair.

Dirt boat ramp at the Castle Rock Fishing Access Site.

Recommendation: Reconstruct the boat ramp to better accommodate recreational use and high water impacts. The Old Nye FAS (Site SW-14) would serve as a good template.

Reach 3: Sites SW-26 to SW-46

(Stillwater River Maps # 3 - 5)

Channel Characteristics: Reach 3 begins as a relatively narrow channel "squeezed" by two landslide deposits on both sides of the river (Site SW-26). The river generally runs to the northeast through a large valley filled with unconsolidated glacial, alluvial, and landslide deposits. The West Fork Stillwater has a large alluvial fan on the west side of the river that extends from Site SW-31 (Nye) to SW-34. The valley border is relatively soft Upper Cretaceous sedimentary bedrock. As the river nears the Castle Rock FAS (Site SW-46), the valley quickly narrows where the sedimentary rock transitions to a much harder Sliderock Mountain volcanic formation.

The channel is single-threaded (120 – 160 feet wide) and slightly entrenched with an average gradient of 0.5%. It has a cobble/gravel river bottom with increasing numbers of larger boulders downstream from the Little Rocky Creek confluence. The floodplain is generally narrow along this reach although there are occasional river segments with a wide floodplain.

The river channel has moved little over the last 100+ years. Sporadic bank armoring was placed along agricultural lands in the past. Recent bank armoring is associated with small tract development. Over 60% of Reach 3 has been subdivided.

Major Tributaries: Burnt Creek, Prairie Creek, West Fork Stillwater, Little Rocky Creek, Stanley Coulee and Magpie Creek.

Lower end of the reach near Site SW-42. Along most of Reach 3, the river is a single-threaded channel with a small floodplain and narrow riparian corridor.

Riparian Characteristics: The riparian corridor is generally a narrow band along the river although there are exceptions where it can be as wide as 900 feet (near Nye in particular). The riparian overstory is dominated by black cottonwood trees. Snowberry, alder, juniper, water birch, yellow willow, and chokecherry are the common understory shrub species. Sandbar willow patches are found on in-channel gravel bars.

Spotted knapweed plants are thinly scattered along the river fringe. Canada thistle and houndstongue are more widespread.

Site SW-47 Irrigation Structure **Priority: Medium**

(Stillwater River – Map #5)

Irrigation headgate on the east side of the river. The structure is located on an open side channel along a braided section of river below the Castle Rock Fishing Access Site. The headgate has a concrete headwall with a wood slide gate and bypass outlet. The wing walls and outlet apron footings are being scoured. The existing by-pass outlet is too narrow for most floating debris to pass. Debris jams place excessive pressure on the structure and the upstream channel bank. It is also a hazard to clear when the water is high.

Traces of an old irrigation ditch and structure can be seen upstream along the east bank. This system was probably operational sometime in the first half of the 20th century.

Irrigation concrete headgate and bypass structure on side channel.

Recommendation: Replace the entire structure using a design that will include a much wider by-pass outlet to pass woody debris.

Site SW-48 Stream Crossing – Private Bridge **Priority: No Action**

(Stillwater River – Map #5)

Steel rail car bridge with wood planking. It sits on concrete abutments and two in-channel bridge supports. Rock rip-rap was placed along the east abutment and around the bridge supports. The bridge has a 110 foot span with 12 feet of freeboard between the bridge and the river. The bridge constricts the river by 10 – 15%. A fence and livestock water gap are located on the east bank downstream from the bridge.

SW-49 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #5)

Rock rip-rap along 60 feet of the south bank. The rip-rap consists of small round boulders dumped over the bank. Some old metal pieces are included with the rip-rap. The river is up to 40% wider at this site.

Site SW-50 Stream Crossing – Private Bridge **Priority: High**

(Stillwater River – Map #6)

Old wood beam bridge that is 170 feet long. The abutments and four mid-channel bridge supports are log/steel pipe cribs partially filled with rock. The bridge supports are in poor condition and appear to be unstable. They are currently shored up with steel pipes on the upstream side of the bridge. A mid-channel bar has formed upstream from one of the bridge supports. This bridge is a hazard and is probably not suitable for vehicle use.

Old wood bridge with log/rock crib mid-channel supports and abutments.

Log bridge supports are in poor condition. Steel pipes are being used to shore up the bridge.

Recommendation: Remove the old bridge from the river before it collapses. Prior to removal, contact the Montana State Historical Preservation Office to document the structure because it is the last remaining wood crib bridge on the Stillwater River. All material should be carefully removed from the active river channel and disposed of off-site. A new bridge design should incorporate a total span of the river, preferably without any mid-channel supports.

Site SW-51 Small Tracts – Foust Subdivision **Priority: High**

(Stillwater River – Map #6)

Over 30 small tracts border the river on 0.7 miles of the northwest side. The tracts are typically less than 1 acre in size. Most tracts have houses within 50 feet of the river's edge. Several tract owners have installed bank stabilization (rock rip-rap, block retaining walls, decks, and jetties), cleared riparian vegetation and placed domestic pumps in the river.

Individual small tract impacts to channel stability, in-stream flow, and water quality are usually minimal, but cumulatively they pose a significant risk to the Stillwater River.

Small tracts: buildings on the river's edge. Most small tract landowners have placed pumps in the river for domestic irrigation.

Recommendation: Develop and implement a small tract outreach and assistance program to help landowners better understand how to minimize their impacts on the river. Program topics would include noxious weed management, water rights, septic maintenance, riparian vegetation, suitable building locations, and basic river dynamics.

Site SW-52 Stream Crossing – Private Bridge **Priority: No Action**

(Stillwater River – Map #6)

Steel bridge that has a 110 foot free span without mid-channel bridge supports. There is 8 feet of freeboard between the channel and bridge beams. The concrete abutments do not encroach on the river. The west abutment is faced with rock rip-rap. The bridge is rusty, but appears to be in good condition.

Site SW-53 Bank Stabilization – Rock Rip-Rap **Priority: Low**

(Stillwater River – Map #6)

About 100 feet of rock rip-rap (1-3 foot diameter boulders) lines the south side of the river downstream from the bridge (SW-52). The rip-rap was placed to protect buildings 20 – 30 feet from the river's edge. A small yard pump is located in the river at the lower end of the rip-rapped section.

Downstream, along the south bank, the riparian vegetation is impacted by heavy livestock use.

Riparian buffer being impacted by heavy livestock use.

Recommendation: Build a riparian fence (portable electric) along 1,000 feet of bank to allow the riparian corridor to recover. Incorporate a water gap or develop off-stream livestock water as needed. Planting young cottonwood cuttings would speed the recovery.

Site SW-54 Bank Stabilization – Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #6)

About 80 feet of rock rip-rap constructed of round boulders and cobbles is loosely scattered along the south bank next to a house. The house is 30 feet from the river and fenced out of the surrounding pasture. The riparian buffer is heavily impacted by livestock.

Site SW-55 Irrigation Headgate/Diversion Structure – Dyer Ditch **Priority: Medium**

(Stillwater River – Map #6)

Irrigation cross-channel rock diversion and concrete headgate. The rock diversion extends 140 feet across the river. It is a low-head dam that raises the water 1 – 2 feet during low flows. Some rock has slipped off the structure either because of ice or high water.

The upper ditch is inset in the river channel, paralleling the north bank. The upper 200 feet requires periodic maintenance after high water events. A concrete headgate and by-pass structure are located 500 feet down the open-inlet ditch. The headgate has a wood slide gate to control flows into the ditch. The by-pass outlet, next to the headgate, is about 3 feet above the river and can be checked up with boards. The outlet opening is narrow and does not provide for passage of large floating debris. The overall condition of the structure is poor; the wing walls and outlet apron are being scoured. The priority dates of the Dyer Ditch water rights range from 1910 to 1954.

Cross-channel rock diversion at the head of the Dyer Ditch.

Concrete headgate and by-pass structure about 500 feet down the ditch.

Recommendation: Replace the headgate and by-pass structure. The new structure should include a much wider by-pass outlet that will accommodate passage of woody debris. Consider shortening the inlet canal and moving the rock diversion downstream approximately 200 feet.

Site SW-56 Stream Crossing – Private Bridge **Priority: Medium**

(Stillwater River – Map #6)

Steel beam bridge on the Bliss Road. The bridge was built in a good location on a straight section between bends. The bridge has a 140 foot span across the river with 8 feet of freeboard above the river. The abutments are rock-filled wood cribs protected with cobble rip-rap. The three bridge supports (steel pipes connected to a concrete base) and boulders placed around them catch large woody debris. The bridge is a potential safety hazard to river recreationists.

Bridge with mid-channel supports faced with large boulders.

Recommendation: When this bridge is ready to be replaced, construct the new bridge in the same location with as few mid-channel supports as possible.

Site SW-57 Bank Stabilization – Rock Rip-Rap/Wall **Priority: No Action**

(Stillwater River – Map #6)

Old rock rip-rap and rock wall/concrete patio encroaching nearly 10 feet into the channel. These structures are associated with a house located about 25 feet off the river.

Site SW-58 Small Tracts – West Subdivision **Priority: High**

(Stillwater River – Map #6)

The West Subdivision has 10 small tracts along 0.4 miles of the north river bank. The tracts are 1 – 2 acres in size. Most tracts have houses built on the terrace, 5 – 8 feet in elevation above the river and less than 60 feet from the river's edge. Some loosely scattered boulders are serving as bank stabilization along a few tracts. Many tract owners have pumps in the river for domestic use.

Individual small tract impacts to riparian vegetation, channel stability, in-stream flow, and water quality are usually minimal, but cumulatively they pose a significant risk to the Stillwater River.

West Subdivision: buildings on the river's edge with large boulders in the foreground being used for bank stabilization. Many small tracts have domestic pumps placed in the river to irrigate landscaped yards.

Recommendation: Develop and implement a small tract outreach and assistance program to help landowners better understand how to minimize their impacts on the river. Program topics would include noxious weed management, water rights, septic maintenance, suitable building locations, and basic river dynamics.

Site SW-59 Irrigation Flume Supports **Priority: No Action**
(Stillwater River – Map #6)
Old irrigation flume supports on both sides of the river. A large mid-channel rock was used as a flume support. The flume was removed and the fields on the east terrace haven't been irrigated in over 20 years.

Downstream from Site SW-59, along the west side of the river, water seeps along the toe of the bank are coming from upslope irrigation ditch leakage.

Site SW-60 Stream Crossing – Bridge Abutments/Support **Priority: Low**
(Stillwater River – Map #6)
A bridge was once located on the Lower Midnight Road and used as recently as 15 years ago. The bridge and one support were removed in the late 2000s; both concrete abutments and a second mid-channel bridge support remain. The north abutment has been undercut and is leaning into the river. The mid-channel bridge support is 40 feet from the south abutment and may pose a safety hazard to floaters during high flows.

Old bridge abutments with a mid-channel support near the south bank.

Recommendation: Remove the mid-channel bridge support from the river.

Site SW-61 Small Tracts – Midnight Ranch Tracts and North Cabin Sites **Priority: High**
(Stillwater River – Map #6)
There are 12 small tracts from the Midnight Ranch Tracts and 18 small tracts from the North Cabin Sites along 1.5 miles of the south river bank. The Midnight Ranch tracts range in size from less than 1 acre to over 20 acres. Most are developed with houses and roads. The North Cabin Site tracts are smaller, about 1 acre in size. Nearly all of the North Cabin tracts have houses and landscaped yards. Bank erosion/scour is negligible because of the natural river armoring, however small tract owners have still placed rock rip-rap, jetties, gravel dikes and/or retaining walls along the bank. Most rip-rap includes scattered cobbles and boulders, 0.5 – 2 foot in diameter. Most tract owners have placed small pumps in the river for landscape irrigation.

The Stillwater River Road (420) parallels the river along the north bank for about 0.3 miles. Sediment washing off the road during heavy run-off eventually reaches the river.

Native riparian vegetation often cleared to accommodate small tract landscaping.

Recommendation: Develop and implement a small tract outreach and assistance program to help landowners understand how to minimize their impacts on the river. Program topics would include noxious weed management, water rights, septic maintenance, riparian vegetation, suitable building locations, and basic river dynamics.

SW-62 Small Tracts – Falcon Ridge Subdivision and North Cabin Sites **Priority: High**
(Stillwater River – Map #6)
There are 12 small tracts in the Falcon Ledge Subdivision and 3 small tracts in the North Cabin Sites along 0.6 miles of the north river bank. Five small tracts not associated with either subdivision are also included in this site. The Beehive Community Center is one of them. The Falcon Ledge Subdivision is relatively new and undeveloped, other than internal roads. The tracts are 1 – 2 acres in size.

The three North Cabin Sites are part of a larger subdivision that lies mostly on the south side of the river (Site SW-61). These tracts are less than 1 acre each and wedged between the county road and the river. Nearly all the North Cabin tracts have houses and landscaping. There are short sections of cobble rip-rap associated with some of the tracts.

Individual small tract impacts to channel stability, in-stream flow, and water quality are usually minimal, but cumulatively they pose a significant risk to the Stillwater River.

The newly subdivided lands have not yet been fully developed. There are a few older sheds and buildings along the river that pre-date the subdivision.

Recommendation: The Falcon Ledge Subdivision would be a high priority for a small tract outreach and assistance program since it has not yet been developed. The program would help new landowners better understand how to minimize their impacts on the river: noxious weed management, water rights, septic maintenance, suitable building locations, and basic river function.

Site SW-63 Stream Crossing – Private Bridge **Priority: No Action**

(Stillwater River – Map #7)

Steel beam bridge on the Midnight Canyon Road. The bridge has a 125 foot span and sits on concrete abutments and two mid-channel concrete supports. All are faced with small boulders.

Upstream from the south abutment, a riverfront house has rock retaining walls that tie into the abutment. A small pump house downstream from the south abutment provides irrigation water for a landscaped yard on the upper terrace.

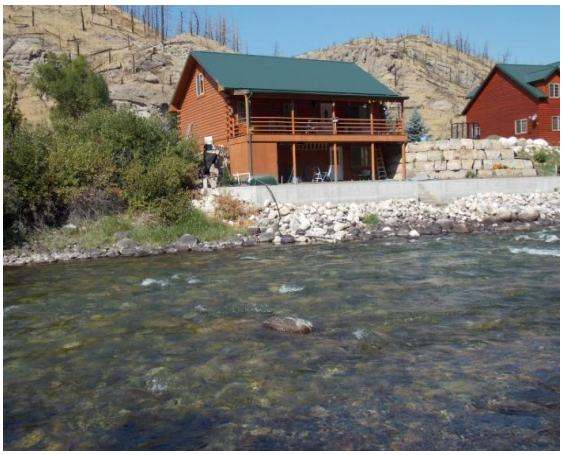
SW-64 Small Tracts – Kratz Subdivision and Other Small Tracts **Priority: High**

(Stillwater River – Map #7)

The subdivision has 11 small tracts along 0.8 miles of the river. Houses are built on the west bank between the county road and river. These tracts extend across the river, but the east side is only accessible by wading or boat. Other small tracts at Site SW-64 include: one North Cabins Site, two Birdhead Ranch Tracts, and four small tracts not associated with an established subdivision. The Kratz Subdivision is mostly 2 acre tracts. The others tracts vary in size from 1.5 – 7 acres. This subdivision was heavily impacted by the 2006 Derby Fire.

Most houses are built on the upper bank, less than 30 feet from the active river. A number of retaining walls have been constructed using gravel gabions, concrete and rock. Most tract owners have placed small pumps in the river for landscape irrigation. Algal growth in the river is more pronounced. The riparian buffer is in good condition.

Individual small tract impacts to channel stability, in-stream flow, and water quality are usually minimal, but cumulatively they pose a significant risk to the Stillwater River.



The subdivision has a high number of retaining walls bordering the river. Most tracts have pumps in the river for landscape irrigation.

Filamentous algae are prominent along this reach.

Recommendation: Develop and implement a small tract outreach and assistance program to help landowners understand how to minimize their impacts on the river. Program topics would include noxious weed management, water rights, septic maintenance, suitable building locations, and basic river dynamics.

Site SW-65 Rock Retaining Wall/Cable Car **Priority: No Action**

(Stillwater River – Map #7)

Two tier rock retaining wall on the west bank that serves as a landing and anchor point for a cable car that crosses the river. The site is located on an undeveloped tract in the Kratz Subdivision.

Site SW-66 Small Tracts – Birdhead Ranch Tracts **Priority: High**

(Stillwater River – Map #7)

The Birdhead Ranch subdivision has 17 small tracts along 0.6 miles of the southeast river bank that range in size from 1 – 5 acres. Some houses are off-set from the river by as much as 150 feet. Others have been built directly on the river's edge. Short sections of rip-rap (small round boulders) line the bank along some of these tracts. Most of the rock was poorly placed and is only partially effective. The subdivision was developed in the 1980s.

This subdivision was heavily impacted by the 2006 Derby Fire. The narrow riparian buffer along the river was burned, but is recovering well. Leafy spurge was noted here for the first time during this assessment.

The Stillwater River Road (420) parallels the river along the north bank for about 0.3 miles. Sediment washing off the road during heavy run-off eventually reaches the river.

Individual small tract impacts to channel stability, in-stream flow, and water quality are usually minimal, but cumulatively they pose a significant risk to the Stillwater River.

Riparian vegetation regrowth along the river banks and on the gravel bars following the 2006 Derby Fire.

Recommendation: Develop and implement a small tract outreach and assistance program to help landowners better understand how to minimize their impacts on the river. Since this subdivision is located on a porous alluvial fan, proper septic installation and maintenance are especially important. Noxious weeds have increased significantly since the Derby Fire. Tract owners need to cooperatively control noxious weeds in their subdivision.

Site SW-67 Stream Crossing – Private Bridge **Priority: No Action**
(Stillwater River – Map #7)
Steel railroad car bridge on Birdhead Lane. It has a 150 foot span across the river with two steel rock-filled bridge supports. The north abutment is concrete and the south abutment is rock. There is 8 feet of freeboard between the river and bridge beams.

Site SW-68 Small Tracts – Riddle's Cliff Subdivision **Priority: High**
(Stillwater River – Map #7)
The 12 Riddle's Cliff tracts are located on 0.2 miles of the north river bank on an inside bend. The subdivision was developed in the early 1980s. The tracts are less than 0.5 acres in size and are all developed. Most houses are less than 30 feet from the river, often associated with bank stabilization (rock rip-rap and retaining wall) and in-river pumps. In the late summer on the downstream end of the subdivision, a large gravel cross-channel irrigation check dam is constructed to divert water into the Stillwater Ditch. See description for Site SW-69.

Individual small tract impacts to channel stability, in-stream flow, and water quality are usually minimal, but cumulatively they pose a significant risk to the Stillwater River.

Riddle's Cliff: riverfront houses have been built along an inside bend.

Recommendation: Develop and implement a small tract outreach and assistance program to help landowners understand how to minimize their impacts on the river. Program topics would include noxious weed management, water rights, septic maintenance, suitable building locations, and basic river dynamics.

Site SW-69 Stream Crossing – County Bridge **Priority: No Action**
(Stillwater River – Map #7)
Concrete county bridge on the Stillwater River Road (420). It has a 130 foot free span with no bridge supports. The concrete abutments are faced by rock rip-rap. Exposed rebar at the toe of the east abutment is a hazard to recreationists. There was an old bridge 350 feet downstream as shown on the 1903 GLO map and 1951 aerial photography.

Site SW-70 Irrigation Headgate/Diversion – Stillwater Ditch **Priority: High**
(Stillwater River – Map #7)
A gravel-cobble check diversion traverses the river upstream from the county bridge (Site SW-69). The diversion extends 250 feet upstream at an angle, raising the water 2 – 3 feet. The diversion needs to be rebuilt once or twice each summer after high water. The delivery canal is 370 feet long and passes under the county bridge approach before reaching the headgate and by-pass structure.

The concrete headgate/by-pass structure is located 100 feet below the county bridge on the east side of the river. The headgate (concrete w/metal screw gate) has recently been replaced. Floating debris tends to hang up at the structure because the by-pass outlet is too narrow and the slide gate is inset too far.

The Stillwater Ditch Company's water right is almost 50 cfs. Most of their water rights have a priority date of 1900.

Spotted knapweed and leafy spurge infestations are moderate to heavy. They are especially bad where the ground is disturbed.

Gravel/cobble cross-channel diversion pushed up each year following high water.

Headgate and by-pass structure in the canal, north of the county road.

Recommendation:

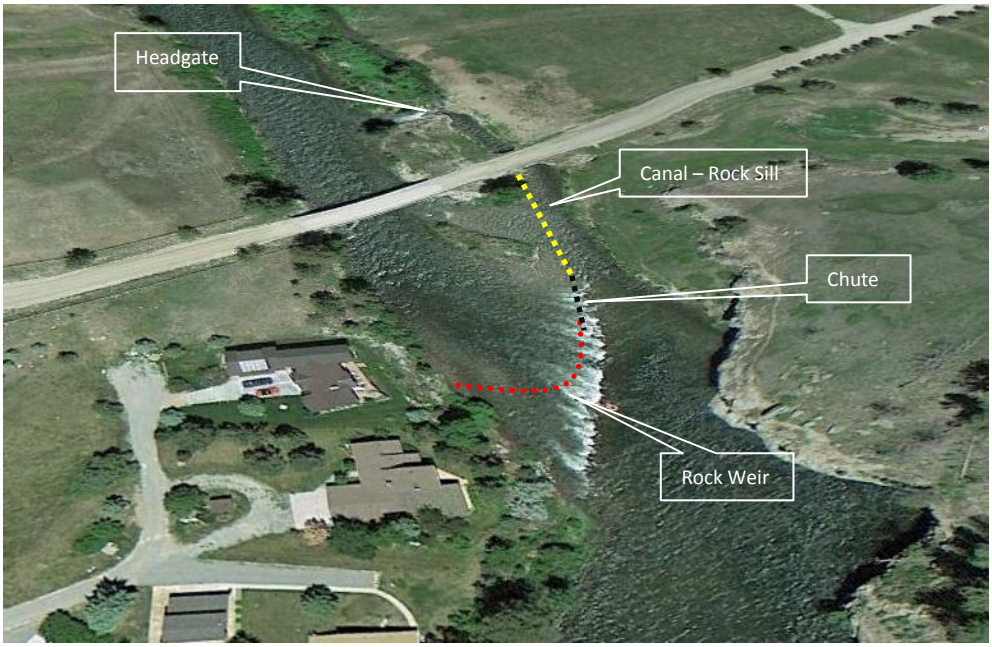
1) Construct a permanent cross-channel weir to elevate and divert water down the canal (red dashed line on photo below). It may require a series of two weirs to obtain the required elevation. The weir would consist of large footer rocks in the bed of the stream with large rocks placed on the footer rocks to obtain the necessary elevation. A rock sill (yellow dashed line) would be placed along the canal perimeter between the weir and the county road underpass. The sill would be set at an elevation to maintain adequate flow to the headgate while allowing high water to pass.

To take pressure off the canal, allow passage of ice and bedload, and reduce the hazard to rafters, a chute could be incorporated into the weir. The chute opening would be at least 80 feet wide although the location and opening width would need to be determined by a detailed hydrology/hydraulic analysis. During the irrigation season when flows are low, portable pre-cast concrete blocks would be placed in the chute to check the water up to the needed elevation. It would take about 15 blocks (1500 – 2000 lbs. each) to fill the gap. The blocks can be cast in a wide variety of sizes, shapes, and weights to fit the diversion alignment, stream velocity, and equipment lift capacities. These blocks would be placed after summer run-off and removed in the fall following the irrigation season. A firm bed would be maintained to allow equipment (front end loader) to place and remove the blocks. This recommendation requires additional operational time and expense each year to make the system functional, but it would eliminate the on-going expense and impacts of reconstructing a gravel diversion each year.

A simple structure could be incorporated with the rock sill/diversion at the head of the canal to divert floating debris away from the canal inlet. This would reduce the debris problems in the canal and at the headgate.

2) The water users need to make adjustments on their new headgate/by-pass structure. The slide gate should be moved forward to minimize woody debris hanging up on the structure. The by-pass outlet needs to be widened to pass larger debris.

Implementation of the recommendations will require a detailed engineering design to determine project feasibility, weir alignment, rock size, chute opening, estimated costs, etc. A project of this nature would be competitive for state/federal financial assistance.



Site SW-71 Stream Crossing – Private Bridge **Priority: No Action**
(Stillwater River – Map #7)
Steel beam bridge on Trout Creek Trail. It has a 180 foot span across the river with three large metal tank bridge supports. It is not known what they are filled with. Woody debris tends to hang up on the supports. The size and number of bridge supports are excessive for what is needed. The end abutments are rock with some concrete. There is 7 feet of freeboard between the river and bridge beams.

Upstream from the bridge, the bank near the house is lined with two short sections of rip-rap 50 – 80 feet long constructed of 1 – 2 foot diameter cobbles and boulders. Riparian vegetation is growing up through the rip-rap.

Downstream from the bridge, there is a water control structure on Stillwater Ditch. Trout Creek enters the river on opposite bank.

From Sites SW-70 to SW-72, seepage from the Stillwater Ditch can be seen entering the river along the south bank.

SW-72 Inverted Siphon – Stillwater Ditch **Priority: No Action**
(Stillwater River – Map #7)
Inverted concrete pipe siphon beneath the Stillwater River. The siphon was built in the early 1980s replacing an old leaking flume.

Site SW-73 Bank Stabilization – Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #7)

Rock rip-rap along the Stillwater River Road for over 400 feet. The rip-rap is mostly large cobbles and small boulders dumped along the toe of the road grade. The Stillwater River Road is about 15 feet above the channel.

An old river meander (Blueball Lake) lies south of the county road. A bent-up 36 inch diameter CMP pipe under the county road connects the northeast end of Blueball Lake to the Stillwater River. It is not known whether this pipe is functional or not.

Site SW-74 Irrigation Flume – Stillwater Ditch **Priority: No Action**

(Stillwater River – Map #8)

Steel pipe flume on the north side of the river across from the Cliff Swallow Fishing Access Site. The flume extends 500 feet across bedrock outcrops. It leaks when filled with water.

Site SW-75 Boat Ramp – Montana FWP Cliff Swallow Fishing Access Site **Priority: Low**

(Stillwater River – Map #8)

Dirt boat ramp at the Cliff Swallow Fishing Access Site (160 acres) on the south side of the river. The launch ramp is located at the downstream end of the Fishing Access Site. It is a difficult launch site with a 3 – 4 foot drop off the terrace bank.

Launch area at the Cliff Swallow Fishing Access Site.

Recommendation: Reconstruct the boat ramp to better accommodate recreational use and high water impacts. The Old Nye FAS (Site SW-14) would serve as a good template.

Site SW-76 Irrigation Diversion – Madison Ditch **Priority: No Action**

(Stillwater River – Map #8)

An old irrigation rock diversion on the north bank across from FAS boat ramp (Site SW-75). The diversion is 800 feet long and constructed with 1 – 3 foot diameter boulders. There is no water control headgate at the entrance of the ditch. The ditch is clogged with debris and is currently not being used. The status of the ditch is unknown since the landowner did not participate in the river assessment. The Madison Ditch has an 1893 water right.

The landowner between Site SW-76 and SW-77 chose not to participate in the stream assessment.

Reach 4: Site SW-46 to SW-76

(Stillwater River Map #'s 5 – 8)

Channel Characteristics: Reach 4 is a relatively narrow canyon bordered by the Sliderock Mountain volcanic formation. The valley varies in width from ½ mile near Beehive to less than 400 feet upstream from Cliff Swallow.

The channel is single-threaded (120 – 160 feet wide) and slightly to moderately entrenched. The river has an average gradient of 0.7%, higher than the upstream reach. It has a cobble/boulder armored river channel with a narrow floodplain.

The river has moved very little over the last 100+ years. When this reach was under traditional agriculture use, there was little need for bank armoring. Over the last 40 years, bank armoring has increased exponentially with the proliferation of subdivisions and small tracts. Along 55% of this reach, there are small tracts on one side of the river and/or the other.

Major Tributaries: Bad Canyon, Dark Canyon, Midnight Canyon, Trout Creek, and Crazy Man Creek.

Near Site SW-64. This reach is a canyon section surrounded by hard volcanic bedrock. The river is a single-threaded channel with a narrow floodplain and riparian corridor. Small tract development is especially dense along this reach.

Riparian Characteristics: A large percentage of this reach was impacted by the 2006 Derby Fire. The riparian vegetation that burned is making a rapid recovery. The riparian corridor is generally a narrow band of black cottonwood trees with patches of conifers. Snowberry, alder, sandbar willow, and chokecherry are the more common understory native shrubs.

Noxious weed infestations expanded substantially following the Derby Fire. Spotted knapweed plants and leafy spurge plants are common along the river fringe and adjacent terrace banks.

The 2006 Derby Mountain Fire burned across the Stillwater River along most of this reach.

Site SW-77 Irrigation Headgate/Diversion – Yanzick Ditch **Priority: High**

(Stillwater River – Map #8)

Irrigation headgate and gravel diversion located on the east side of the river, just past the Madison Grade. The earliest water rights priority date is 1905. The 1946 DNRC Water Resources Survey shows the original point of diversion was located one mile upstream.

The gravel/cobble wing diversion extends about 400 feet upstream from the mouth of the delivery canal. The diversion requires periodic maintenance and reconstruction after high water events. The 400 foot long delivery canal is stable and well vegetated.

The headgate structure has been reinforced with concrete and an old wooden gate was replaced with a steel slide gate. The by-pass outlet is at a 90° angle to the headgate with a narrow opening that can be checked up with boards. The open canal and structure catch a large amount of floating debris during high flows. The outlet apron is being scoured.

Long gravel/cobble wing diversion extending upstream from the delivery canal and headgate.

Irrigation headwall and metal slide gate with a by-pass outlet on the left.

Recommendation:

1) Construct a permanent weir (red dashed line on photo below) to elevate and divert water into the delivery canal. The weir (180 feet) would arc upstream and be built with large footer rocks keyed into the river bed. The footer rocks would be overlain with large rocks to check the water to the necessary elevation.

To take pressure off the weir, allow passage of ice and bedload, and reduce the hazard to rafters, a chute could be incorporated into the weir. The chute opening would be at least 80 feet wide although the exact opening width and location would need to be determined by a detailed hydrology/hydraulic analysis. During the irrigation season when flows are low, portable pre-cast concrete blocks would be placed in the chute to check the water up to the needed elevation. It would take about 15 blocks (1500 – 2000 lbs. each) to fill the gap. The blocks can be cast in a wide variety of sizes, shapes, and weights to fit the diversion alignment, stream velocity, and equipment lift capacities. These blocks would be placed after summer run-off and removed in the fall following the irrigation season. A firm bed would be maintained to allow equipment (front end loader) to place and remove the blocks. This recommendation requires additional operation time to place and

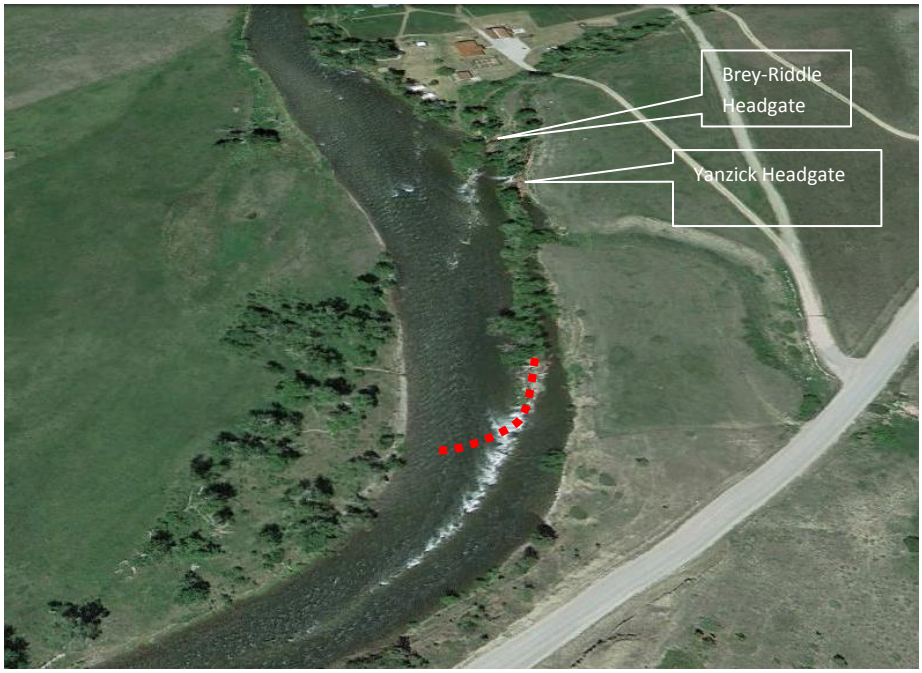
remove the blocks each year, but it would eliminate the on-going expense and impacts of reconstructing the gravel diversion after each high water.

A simple structure could be constructed at the head of the delivery canal to divert floating debris back into the river. This would reduce the debris problems in the canal and at the headgate.

2) The water users may want to make some adjustments to their headgate/by-pass structure. The by-pass outlet should be widened to more effectively pass floating debris and the apron footing needs to be patched.

3) Option: Consolidate the Yanzick Ditch infrastructure with the Brey-Riddle Ditch. The two headwalls are only 125 feet apart. Consolidation of ditches is sometimes a difficult path: initial expense, sorting out operational responsibilities, and maintaining individual water rights. But, it is not impossible and there can be several benefits. With this option there would be a headgate, diversion and ditch (700 feet) before splitting off into existing laterals. The capacity of the headgate and ditch would likely need to be increased to deliver sufficient water to all water users. This option has the benefit of significantly reducing long-term maintenance costs and impacts to the river.

Implementation of the recommendations would require a detailed engineering design to determine project feasibility, weir alignment, rock size, chute opening, estimated costs, etc. A project of this nature would be competitive for state/federal financial assistance.



Site SW-78 Irrigation Headgate/Diversion – Brey-Riddle Ditch **Priority: Medium**

(Stillwater River – Map #8)

The irrigation headgate and gravel diversion are located on the east side of the river about 125 feet downstream from the Yanzick headgate/diversion. There are several water rights on this ditch with priority dates that range from 1901 – 1908.

The gravel/cobble wing diversion extends about 250 feet upstream from the mouth of the delivery canal and two-thirds of the way across the river. The diversion requires periodic maintenance and reconstruction to provide adequate flow to the headgate. The 125 foot long delivery canal is stable and well vegetated.

The concrete headgate has a steel screw gate and a by-pass outlet. The by-pass outlet can be blocked with boards/canvas to check water into the ditch. The open canal and narrow by-pass outlet tend to capture large amounts of floating debris during high flows. The structure's wing walls are being scoured.

There is a short section of rock rip-rap and minor bank scouring on the opposite bank. The bank scour may be caused by the two gravel wing walls from the Yanzick and Brey-Riddle diversions.

About 900 feet downstream on the east bank is a private boat launch. The small ramp is dirt and lined with hand-placed cobbles.

Gravel/cobble wing diversion extending upstream and partially across the river.

Irrigation headwall and metal screw gate with a by-pass outlet on the left.

<u>Recommendation:</u> Same general recommendation as for Site SW-77 (Yanzick Headgate/Diversion)

1) Construct a permanent cross-channel weir (red dashed line on photo below) to elevate and divert water into the canal. The weir (160 feet) would arc upstream and be built with large footer rocks keyed into the river bed. The footer rocks would be overlain with large rocks to raise the water to the necessary elevation.

To allow passage of ice and bedload, a chute could be incorporated into the weir. The chute opening would be at least 60 feet wide although the exact opening width and location would need

to be determined by a detailed hydrology/hydraulic analysis. During the irrigation season when flows are low, portable pre-cast concrete blocks would be placed in the chute to check the water up to the needed elevation. It would take about 10 – 12 blocks (1500 – 2000 lbs. each) to fill the gap. The blocks can be cast in a wide variety of sizes, shapes, and weights to fit the diversion alignment, stream velocity, and equipment lift capacities. These blocks would be placed after summer run-off and removed in the fall following the irrigation season. A firm bed would be maintained to allow equipment (front end loader) to place and remove the blocks. This recommendation requires additional operation time to place and remove the blocks each year, but it would eliminate the on-going expense and impacts of reconstructing the gravel diversion after each high water.

A simple structure could be constructed at the head of the delivery canal to divert floating debris back into the river. This would reduce the debris problems in the canal and at the headgate.

2) The water users need to make adjustments on their headgate/by-pass structure. The by-pass outlet should be widened to better pass debris and the wing wall footings need to be patched.

1) Option: Consider the possibility of consolidating this infrastructure with the Yanzick Ditch. The two headwalls are only 125 feet apart. Consolidation of ditches is sometimes a difficult path: initial expense, sorting out operational responsibilities, and maintaining individual water rights. But, it is not impossible and there are several benefits. With this option there would be a common headgate and ditch (700 feet) before splitting off into existing laterals. The capacity of the headgate and ditch would likely need to be increased to deliver sufficient water to all water users. This option has the benefit of significantly reducing long-term maintenance costs and impacts to the river.

Implementation of the recommendations would require a detailed engineering design to determine project feasibility, weir alignment, rock size, chute opening, estimated costs, etc. A project of this nature would be competitive for state/federal financial assistance.

Site SW-79 Irrigation Headgate/Diversion – Phelps Ditch **Priority: Medium**
(Stillwater River – Map #8)
The irrigation headgate and check structure are located in a side channel on the east side of the river. The water rights date back to 1891. The 1901 GLO map shows the diversion point at the same location that it is now.

The boulder/cobble wing diversion extends 220 feet across the river, aligned in an upstream arc. It raises the water to 2 feet, diverting flow into the east side channel towards the headgate. The cross-channel diversion is built with a variety of rock sizes ranging from small gravel to large boulders. The diversion requires varying degrees of reconstruction after high water events.

The concrete headgate has a steel screw gate and a check structure that spans the side channel (18 feet). Boards are used in the check structure to elevate the water into the headgate and ditch. The alignment and wide opening of the check structure provide clear passage of floating debris.

Rock diversion extending across the river at the head of the side channel.

Irrigation headgate and check structure on the side channel.

Recommendation: The cross channel rock diversion and headgate structure are well laid out. To make it more permanent, large rock would replace the gravel and cobbles currently being used in the diversion. This would reduce the need for equipment to be in the river reconstructing the diversion after most high water events.

Site SW-80 Irrigation Headgate/Diversion – Larson-Johnson Ditch **Priority: High**
(Stillwater River – Map #8)
The irrigation headgate and check structure are located on the north side of the river. The 1899 GLO map shows the headgate in the same location that it is now.

The boulder/cobble wing diversion extends 400 feet upstream and across the river. It raises the water level about 2 feet, diverting flow into the north delivery ditch and headgate. The wing diversion is built with a variety of rock sizes ranging from gravels to small boulders. It requires maintenance and replacement of rock after most high water events.

The concrete/wood headgate has a wooden slide gate and a by-pass outlet. The opening on the by-pass outlet is too narrow and does not allow for passage of woody debris. Large amounts of floating debris tend to accumulate in front of the headgate.

Downstream from the headgate, there is seepage along the river bank. The water user believes that the seepage is coming from irrigation upslope and not from the Larson-Johnson Ditch. The Larson-Johnson Ditch water rights date back to 1893.

Long rock wing diversion extending upstream and across the river.

Old concrete and wood headgate with woody debris piled up in front.

Recommendation:

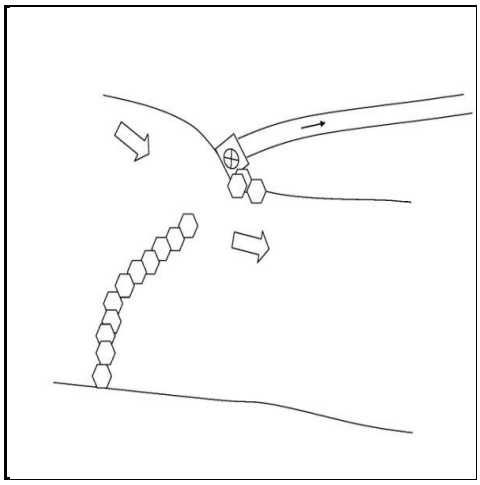
1) Relocate the headgate down-river approximately 180 feet. Align the headgate and diversion to allow passage of bedload and floating debris. See illustrations below.

2) Construct a permanent cross-channel weir (red dashed line on photo below) to elevate and divert water into the canal. The weir (170 feet) would arc upstream and connect to the island near the south bank. It would be built with large footer rocks keyed into the river bed and overlain with large rocks to raise the water to the necessary elevation.

To provide passage of floating debris and bedload, a by-pass chute should be incorporated into the weir close to the headgate. The chute opening would be at least 60 feet wide; however, the optimal opening size would be determined by a detailed hydrology/hydraulic analysis. During the irrigation season when flows are down, portable pre-cast concrete blocks would be placed in the gap to check the water up to the needed elevation. It would take 10 – 12 blocks (1500 – 2000 lbs. each) to fill the gap. The blocks can be cast in a wide variety of sizes, shapes, and weights to fit the diversion alignment, stream velocity, and equipment lift capacities. These blocks would be placed after summer run-off and removed in the fall following the irrigation season. A firm bed would be maintained to allow equipment (front end loader) to place and remove the blocks. This recommendation requires additional operation time to place and remove the blocks each year, but it would eliminate the on-going expense and impacts of maintaining a gravel/cobble diversion after high water events.

Implementation of the recommendations would require a detailed engineering design to determine project feasibility, weir alignment, rock size, chute opening, estimated costs, etc. A project of this nature would be competitive for state/federal financial assistance.

Recommended relocation of the headgate and rock diversion.



Plan view of headgate and diversion. Align headgate and diversion chute to effectively pass bedload and debris.

Site SW-81 Bank Stabilization - Rock Jetty **Priority: No Action**
(Stillwater River – Map #9)
Old rock jetty built on the upper end of a river bend on the north bank. Large angular rock was used to construct the jetty. The intent for the jetty was to prevent the river from undercutting the Larson-Johnson Ditch that follows the curve of the bend.

Site SW-82 Stream Crossing – County Bridge **Priority: No Action**
(Stillwater River – Map #9)
Laminated wood beam bridge on the Spring Creek Road. The bridge has a 110 foot free span supported by concrete abutments. There is 8 feet of freeboard between the bridge beams and the river channel.

The bridge is located on the apex of a bend. The north road approach acts as a floodplain dike restricting out-of-bank flow on the inside bend.

Site SW-83 Corrals/Small Pens/Bank Stabilization – Rock Rip-Rap **Priority: Medium**
(Stillwater River – Map #9)
Corrals, pens, and small pastures along a 0.7 mile reach of river on the north bank. The pastures are generally unfenced from the river. Most of the corrals have a 10 – 30 foot wide fenced buffer.

Two sections of rock rip-rap line the corrals (1 – 2 foot diameter boulders). One section is 200 feet long and the other is 120 feet long. Downstream from the corrals, a shaped bank with rock rip-rap is silted in and has a fenced buffer about 75 feet wide.

On the lower half of Site SW-83, small pastures are unfenced from the river. The riparian vegetation consists of scattered mature cottonwood trees and an understory of grass and bare soil. A pile of old farm implements, metal scrap, and wood on the bank acts as a jetty creating a large downstream eddy. A 40 x 80 foot section of bank has eroded away because of the eddy.

Small pasture next to the river.

Recommendation:

1) Construct a riparian fence (permanent or portable electric) along the river corridor to allow for riparian recovery. Incorporate water gaps or develop an off-stream livestock water alternative. Planting young cottonwood cuttings would speed the recovery.
2) Remove the pile of implements, scrap metal, and wood from the river bank to stop the downstream eddying and bank erosion. Trim low tree branches that are catching floating debris. Fill in the eroded area with gravel topped with soil. Re-vegetate with young willows and cottonwood saplings.

The landowner has expressed a desire to leave the debris pile in-place (it has been there for over 40 years) and to rip-rap the downstream eroded area.

Site SW-84 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #9)

Rock rip-rap along the south bank, upstream from a house built near the river's edge. The rip-rap is approximately 100 feet long and constructed with 2 – 3 foot diameter boulders placed on a 4 foot high bank.

Site SW-84 is located on the south channel of a braided section of river. The mid-channel island has established vegetation on it indicating little change in channel alignment over the last 60 years.

An old abandoned feedlot is located downstream on the south bench next to the river. Annual weeds persist over most of the feedlot area. An electric riparian fence provides a 30 – 50 foot buffer along the terrace edge.

Site SW-85 Irrigation Headgate/Diversion – Tintinger Ditch **Priority: High**

(Stillwater River – Map #9)

The Tintinger Ditch headgate and diversion are located on the north channel of a braided section of the river. Water rights associated with the Tintinger Ditch range from 1893 – 1903.

The boulder/cobble wing diversion extends 180 feet upstream and across the river. After most high water events, maintenance is probably necessary.

The headwall structure is old and in poor condition. The concrete headgate has a metal slide gate with a narrow by-pass outlet. The by-pass outlet is too narrow and poorly aligned to effectively pass floating debris. Debris tends to accumulate in front of the structure.

Downstream from the headgate, an old bridge crosses the side channel (50 foot free span) accessing the mid-channel island. The bridge was built from an old railroad car and sits on large cobble abutments.

Rock wing diversion extending upstream from the headgate on the north channel.

Old concrete headgate and metal slide gate. Woody debris piles up in front of the headgate during high water.

Recommendation:

1) Replace the headgate and diversion. A new headgate and diversion would be designed to pass bedload and floating debris using a similar layout as shown for the Larson-Johnson headgate (Site SW-80).
2) Construct a permanent cross-channel weir (red dashed line on photo below) to divert water to the headgate. The weir (120 feet) would arc upstream, extend across the side channel and tie into the island's north bank. Large footer rocks would be keyed into the river bed and overlain with large rocks to raise the water level to the necessary elevation at the headgate.

To pass floating debris and bedload, a by-pass chute could be incorporated into the weir adjacent to the headgate. The chute opening would be at least 40 feet wide; however the optimal opening size would need to be determined by a detailed hydrology/hydraulic analysis. During the irrigation season when flows are low, portable pre-cast concrete blocks would be placed in the gap to check the water up to the needed elevation. It would take 6 – 8 blocks (1500 – 2000 lbs. each) to fill the gap. The blocks can be cast in a wide variety of sizes, shapes, and weights to fit the diversion

alignment, stream velocity, and equipment lift capacities. These blocks would be placed after summer run-off and removed in the fall following the irrigation season. A firm bed would be maintained to allow equipment (front end loader) to place and remove the blocks. This recommendation does require additional operational time to place and remove the blocks each year; however, it would eliminate the on-going expense and impacts of repairing the existing diversion after most high water event.

Implementation of the recommendations would require a detailed engineering design to determine project feasibility, weir alignment, rock size, chute opening, estimated costs, etc. A project of this nature would be competitive for state/federal financial assistance.

Site SW-86 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #9)

Two segments of bank stabilization on the north side of the river that appears to be fairly old. The first segment is 50 feet of rock rip-rap placed along the toe of a terrace on an outside bend. A house was built on the terrace less than 50 feet from the river. The second segment is rock rip-rap and two jetties along 300 feet of bank adjacent to an irrigated hay field. Both segments of bank stabilization were constructed with loosely-placed angular rock.

The river is braided along this site with multiple channels. The riparian vegetation on the mid-channel islands is well established. Old aerial photography show little change in channel alignment over the last 60 years.

The channel substrate is covered with filamentous algae. The concentration of algae slowly increases as you go downstream.

Site SW-87 Corrals/Water Gap **Priority: High**

(Stillwater River – Map #10)

Corrals and small pens located on an inside bend and low floodplain, north side of the river. A 10 – 30 foot buffer separates the corrals from the river. During high precipitation and snow melt events, nutrients from the corrals may reach the river through surface run-off or from leaching into the shallow water table. A livestock water gap is incorporated in with the corrals. Old aerial photography shows these corrals in the same location for at least 60 years.

Corrals located on the low floodplain with a small livestock water gap.

Recommendation:

NRCS may be willing to complete an evaluation of the corral system to suggest options to reduce the amount of nutrients entering the river. One option is to widen the riparian buffer to 50 feet by relocating the corral pen currently next to the river to the north side of the existing corrals. Additional water development may be necessary if the water gap is removed.

Site SW-88 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #10)

Old rock rip-rap on the southeast bank of the river. The rip-rap lines 350 feet of bank with 1 – 3 foot diameter angular rock. An old floodplain dike was built behind part of the rip-rap. Sometime in the last 15 years, a house was built on the south bench near the upper end of the rip-rap.

Site SW-89 Irrigation Headgate/Diversion – Weir-Crawford Ditch **Priority: Medium**

(Stillwater River – Map #10)

An irrigation headgate and check structure on the north side of the river. The ditch's water rights date back to 1891. A gravel/cobble wing diversion extends 400 feet upstream and across the river. The wing diversion directs water into a well vegetated canal (300 feet long) and headgate/by-pass structure. The wing diversion likely requires maintenance or replacement following most high water events.

The concrete headwall has a wood slide gate and narrow by-pass opening. The structure is in good condition and functions well. Floating debris does not appear to be a problem. There is a 25 foot wide opening in the ditch wall about 40 feet up from the headgate which may pass most of the debris that enters the upper ditch.

Gravel/cobble wing diversion extending upstream from the delivery ditch and headgate.

Concrete headgate with a wood slide gate and by-pass.

Recommendation:

Construct a permanent cross-channel weir to elevate and divert water down the canal. The weir (170 feet) would arc upstream and be tied into the south bank. It would be built with large footer rocks keyed into the river bed with large rocks on top to raise the water to the necessary elevation.

Floating debris may already be adequately addressed with the current opening in the canal wall, but to better pass bedload and reduce the need to dredge the delivery canal, a low-head chute could be incorporated into the weir next to the canal mouth. The chute opening would be at least 40 feet wide; however optimal opening size would need to be determined by a detailed hydrology/hydraulic analysis. During the irrigation season when flows are low, portable pre-cast concrete blocks would be placed in the gap to check the water up to the needed elevation. It would take 8 – 10 blocks (1500 – 2000 lbs. each) to fill the gap. The blocks can be cast in a wide variety of sizes, shapes, and weights to fit the diversion alignment, stream velocity, and equipment lift capacities. These blocks would be placed after summer run-off and removed in the fall following the irrigation season. A firm bed would be maintained to allow equipment (front end loader) to place and remove the blocks. This recommendation requires additional operation time to place and remove the blocks each year, but it would eliminate the on-going expense and impacts of maintaining gravel/cobble diversion after high water events.

Implementation of the recommendations would require a detailed engineering design to determine project feasibility, weir alignment, rock size, chute opening, estimated costs, etc. A project of this nature would be competitive for state/federal financial assistance.

SW-90 Bank Stabilization - Rock Rip-Rap/Jetties/Dikes **Priority: No Action**

(Stillwater River – Map #10)

Small rock jetty on the south bank on the upstream end of a small tract. A house is about 40 feet from the river's edge. A small domestic pump next to the jetty is used for landscape watering.

Site SW-91 Bank Stabilization - Rock Rip-Rap /Jetty **Priority: No Action**

(Stillwater River – Map #10)

Rock rip-rap and jetty along a hay field. The rip-rap is constructed with field cobbles and covers 60 feet of the east river bank. A jetty was built with large angular rocks on the downstream end of the rip-rap.

Site SW-92 Irrigation Headgate/Diversion – Mendenhall Ditch **Priority: High**

(Stillwater River – Map #10)

The Mendenhall headgate and diversion are located on the south side of the river. The Mendenhall Ditch is about 4 miles long, constructed in 1892 by means of teams and slips. In 1944, over 1,000 acres were irrigated under the Mendenhall Ditch (1946 DNRC Water Resources Survey).

The concrete headwall is 40 feet wide and has two screw gates. The by-pass structure next to the headgate is 20 feet wide. The wide opening and alignment of the by-pass structure allows most bedload and floating debris to pass freely. The structure can be blocked with boards to elevate water into the headgate. There is about 3 feet of elevation difference between the by-pass opening and the river channel. Recent repairs were completed in 2001.

The gravel/cobble wing diversion extends 500 feet upstream and across the river. The diversion requires occasional maintenance and replacement of rock after high water events.

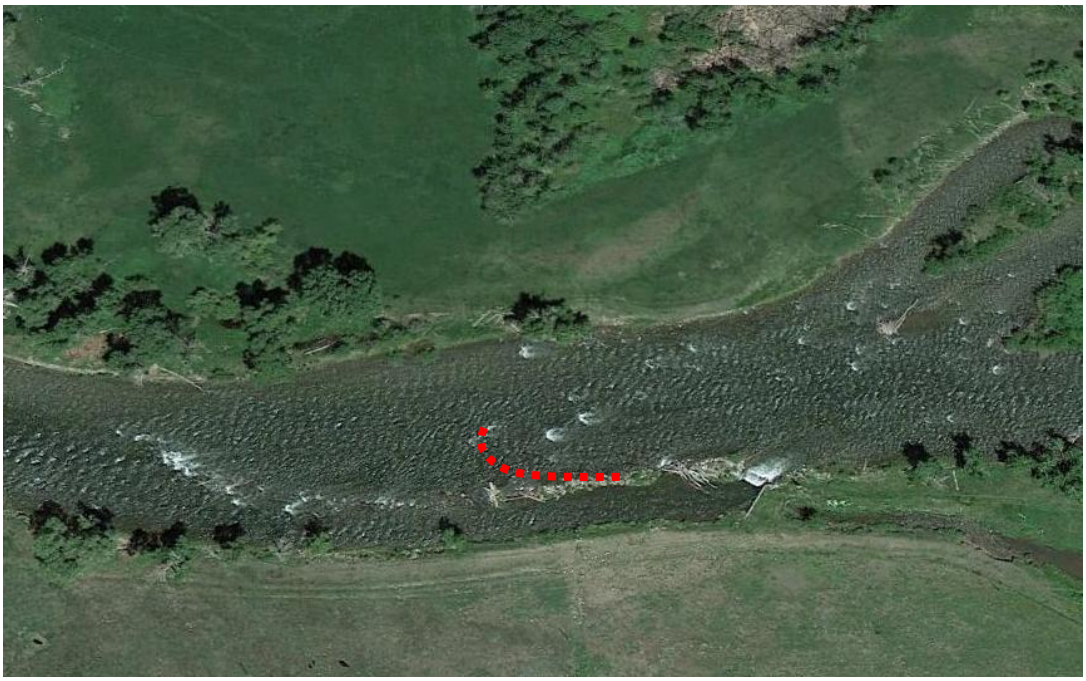
Rock wing diversion extending 500 feet upstream from the Mendenhall Ditch headgate.

Concrete headgate and by-pass structure. The width and alignment of the by-pass accommodate passage of most floating debris.

<u>Recommendation:</u>

Construct a permanent J-hook weir to elevate and divert water towards the headgate (see red dashed line on photo below). The weir (~ 150 feet) would be built with large footer rocks keyed into the river bed with large rocks on top to raise the water to the necessary elevation.

Implementation of the recommendations would require a detailed engineering design to determine project feasibility, weir alignment, rock size, chute opening, estimated costs, etc. A project of this nature would be competitive for state/federal financial assistance.



Site SW-93 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #10)

Old rock rip-rap on the outside bend of a braided channel. The rock, mostly field cobbles and a few scattered boulders, was dumped over an 80 foot long bank on the south bank. A house with an overhanging deck was recently built on the river's edge, upstream from the rip-rapped bend. There is a small pump in the river for landscape watering. Downstream, an old corral and sheds are on the high floodplain next to the rip-rapped bank.

The mid-channel islands have established riparian vegetation. The channel alignment has changed very little over the last 60 years.

Site SW-94 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #10)

Old rock rip-rap along 100 feet of an outside bend on the south side of the river. The rock used for the rip-rap is 1 – 2 foot diameter angular rock. An old river oxbow, south of the rip-rapped bend, is now a wetland. The south bank is freely accessed by livestock and shows heavy browse on the native vegetation. A horse pasture with a riparian fence and water gap are on the opposite bank. The riparian vegetation is in much better condition.

Site SW-95 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #10)

Old cobble rip-rap on 80 feet of the north bank. The rip-rap is located on the upper end of an outside bend along the toe of a high terrace. The Weir-Crawford Ditch, on the terrace bench above the rip-rap, follows the curvature of the bend.

Site SW-96 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #10)

Field cobbles dumped on the south bank along a braided section of river. The cobbles cover approximately 120 feet of the bank.

Site SW-97 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #11)

Rock rip-rap along 140 feet of south bank adjacent to a hay field. The river is braided with most of the flow going down the south channel. The rip-rap is old, but still intact. Large angular rocks, 1 – 4 foot diameter, were used to construct the rip-rap. Riparian vegetation is growing through it.

Site SW-98 Irrigation Headgate/Diversion – J. Kern Ditch **Priority: High**

(Stillwater River – Map #11)

Irrigation headgate on the north channel of a braided section of river. The headgate has a cinder block/concrete headwall with a metal slide gate. The wing walls and upstream apron are scouring. The bypass outlet is 10 feet wide and can be checked up with boards. The headgate alignment and the wide by-pass opening appear to pass most floating debris.

The wing diversion, extending 150 feet upstream, is built with rock that varies from small gravel to 2 foot diameter boulders. It may require maintenance or partial reconstruction following high water events.

The water rights for the J. Kern Ditch date back to 1893. Grove Creek enters the Stillwater River from the south about 1,000 feet downstream from Site SW-98.

The J. Kern headgate located on the north channel of a braided section of river. The photo is looking upstream at the rock wing diversion.

<u>Recommendation:</u>

Construct a cross-channel weir to elevate and divert water down the canal (see red dashed line on photo below). The weir (~70 feet) would arc upstream in a J-hook pattern. It would be tied to the headgate's concrete apron on one end and the channel's south bank on the other. The diversion would be built with large footer rocks keyed into the river bed. Portable pre-cast concrete blocks would be placed on top of the footer rocks to check the water up to the needed elevation. It would take 10 – 12 blocks (1500 – 2000 lbs. each) to build the diversion. The blocks can be cast in a wide

variety of sizes, shapes, and weights to fit the diversion alignment, stream velocity, and equipment lift capacities. These blocks would be placed after summer run-off and removed in the fall following the irrigation season. Bedload and floating debris would easily pass during high water and ice would be less of a problem in the winter. A firm bed would be maintained to allow equipment (front end loader) to place and remove the blocks. This recommendation requires additional operation time to place and remove the blocks each year, but it would eliminate on-going expenses and impacts of reconstructing a temporary rock wing diversion after each high water event.

The headgate's wing walls and inlet apron are in need of repair to prevent further scouring and damage.

Implementation of the recommendations would require a detailed engineering design to determine project feasibility, weir alignment, rock size, estimated costs, etc. A project of this nature would be competitive for state/federal financial assistance.

Portable pre-cast blocks that can be custom built to fit the alignment and size of the diversion.

Site SW-99 Water Control Structure **Priority: No Action**

(Stillwater River – Map #11)

Water control structure on the south side of the river and upstream end of a side channel. The structure is a combination concrete/rock plug with three un-gated culverts (18 inch diameter). The culverts run about half full during late summer base flow. This structure was built in May 2000 (inscribed on concrete) to provide controlled flows into 800 feet of side channel for trout spawning habitat. It is not known how successful the project is.

Site SW-100 Bank Stabilization - Rock Rip-Rap/Corrals **Priority: High**

(Stillwater River – Map #11)

Rock rip-rap on the southeast bank next to a farmstead and corrals. The rock varies in size from cobbles to large angular rock along 600 feet of river bank. The rip-rap is old, but still intact. Riparian vegetation is growing up through the rocks. The rip-rap provides a narrow buffer between the corrals and the river.

Rock rip-rap provides a narrow buffer between the farmstead and the river.

Recommendation:

Request that NRCS complete an evaluation of the corral system to determine if the corrals are contributing excessive nutrients to the river. If mitigation is recommended, options may include widening the riparian buffer and diverting surface drainage away from the river.

Site SW-101 Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Stillwater River – Map #11)

Rock rip-rap on approximately 600 feet of a large bend along the toe of the North Stillwater Road. The rip-rap consists of 2 – 4 foot angular rock. Short sections of the rip-rap are being scouring and need repair.

Site SW-102 Irrigation Headgate/Diversion – Garrigus Ditch **Priority: High**

(Stillwater River – Map #11)

Irrigation headgate on the north river bank, immediately upstream from the Johnson Bridge. The concrete headgate and by-pass structure are old, but in good condition. The headwall has two screw gates. The by-pass has a 10 foot wide opening that can be checked up with boards. There is about 3 feet of elevation difference between the headgate inlet and the river.

The temporary wing diversion and delivery ditch extend nearly 600 feet upstream to a mid-channel island. The delivery ditch is permanent with vegetation growing on it. The temporary wing diversion is built with cobbles and small boulders. The wing diversion requires some degree of reconstruction following most high water events.

The headgate structure is located on an inside bend where the river's main current is naturally directed towards the opposite bank. This is not an ideal location for this structure, creating an on-going dilemma for the water users in getting sufficient water to their headgate. The water users have extended the wing diversion far enough upstream to catch the current before it crosses over to the south bank.

Water rights on the Garrigus Ditch date back to 1893.

Garrigus Ditch headgate and by-pass structure. The Johnson Bridge is in the background..

Recommendation:

The location of the existing headgate on the inside bend reduces the options available for improvement and efficiency. The best location of a headgate is on the downstream limb of an outside bend. This provides direct flow to the headgate and may eliminate the necessity for a diversion. If aligned correctly, the structure would readily pass floating debris and bedload.

For the Garrigus Ditch, one option is to relocate the headgate upstream about 600 feet as shown on the photo below. This option would require a new structure and construction of about 600 feet of new ditch. Obtaining a point of diversion change from DNRC and securing an easement from the landowner would be a precursor to the project. It is an option that would require a substantial investment. The water users may not be willing to implement this plan in the near-term, but when the headgate/by-pass structure is ready for replacement, this option should be seriously considered.

Implementation of the recommendations would require a detailed engineering design to determine project feasibility, weir alignment, rock size, estimated costs, etc. A project of this nature would be competitive for state/federal financial assistance.

Site SW-103 Stream Crossing – Johnson Bridge **Priority: No Action**

(Stillwater River – Map #11)

Wood/steel beam arch bridge resting on wood abutments and two in-channel concrete-filled steel pipe bridge supports. There is an additional support near the north abutment. The bridge has a 160 foot span across the river and a maximum of 15 feet of freeboard between the bridge and the river. This bridge is nearing the end of its life span and will need to be replaced in the near-term. Building a new bridge that is either a free span or, if necessary, one mid-channel bridge support is recommended.

Reach 5: Sites SW-76 to SW-103

(Stillwater River Map #'s 8 – 11)

Channel Characteristics: Once past the Madison Grade, the river quickly transitions from a relatively narrow canyon, restricted by the Sliderock Mountain volcanic formation, to a much wider valley bordered by softer sedimentary rock. The valley is over one mile wide near the Spring Creek Bridge, then narrows to about ¾ mile for the remainder of the reach.

The river is generally single-threaded with intermittent segments of braided channel. The river has an average gradient of 0.6%, slightly less than Reach 4. The channel is slightly to moderately entrenched in the floodplain with a cobble lined river channel. It is somewhat resilient to physical impacts, but not nearly as much as the upstream canyons reach.

The river channel has shifted very little over the last 60 years. The islands in the braided segments typically have established mature riparian vegetation. There is a fair amount of old bank armoring along this reach usually to prevent the river from eroding into an adjacent field or farmstead.

There are 9 major irrigation headgates and diversions. Nearly all of them use temporary wing dikes to divert water into a delivery canal and headgate. Because the wing dikes are temporary, it is

necessary for the water users to repair or rebuild them after most high water events. Several of the headgates have problems with floating debris and bedload because of the canal alignment and/or inadequate by-pass structure opening.

Major Tributaries: Spring Creek, Cow Creek, Sanborn Creek, Jack Stone Creek, and Grove Creek.

Cobble lined river channel. Photo taken near Site SW-93.

Riparian Characteristics: The riparian corridor is generally a narrow band of riparian vegetation along a slightly entrenched, single-threaded channel. The riparian corridor is wider on intermittent sections of river where it becomes braided with mid-channel islands. Most mid-channel islands have established riparian vegetation that is in excellent condition. The riparian overstory is primarily black cottonwood trees with an understory of thin leaf alder, water birch, yellow willow, chokecherry, and buffaloberry.

Leafy spurge infestations are common along this reach. Some patches are being sprayed, many are not.

4.2 West Fork Stillwater River

The West Fork Stillwater River assessment begins at the Keogh Headgate (River Mile 6.2) and ends at its confluence with the Stillwater River (River Mile 0.0).

Site WF-1 Irrigation Headgate **Priority: No Action**

(West Fork Stillwater River - Map #1)

Concrete headwall (dated 1978) with a wheel gate located on the south side of the West Fork. The structure is well placed and does not require an in-channel diversion or check structure. The headgate serves 40 acres of hayland about 2 miles away. The structure is on a segment of river with a high gradient (> 5%), step-pool channel that is naturally armored with large glacial boulders. A water structure (dated 1979) is 80 feet down the ditch from the headgate that controls the amount of water conveyed down the ditch. The ditch was recently cleaned for the second time since 1978.

Site WF-2 Stream Crossing – Private Bridge **Priority: No Action**

(West Fork Stillwater River - Map #1)

Steel railcar bridge supported by large boulder abutments. The bridge, built less than 10 years ago, replaced an old wood bridge.

Site WF-3 Stream Crossing – Private Bridge **Priority: No Action**

(West Fork Stillwater River - Map #1)

Steel railcar bridge supported by concrete abutments. Curry Flat Lane is the road approach on the north side. The bridge is in good condition.

Site WF-4 Bank Stabilization – Rock Rip-Rap **Priority: Low**

(West Fork Stillwater River - Map #1)

Rock rip-rap (2 – 3 foot diameter boulders) was placed on a braided section of river. The rip-rap was installed about 20 years ago to keep the river from migrating towards the south channel away from a landowner's property on the north side of the river.

The river splits about 550 feet upstream of Site WF-4. Both channels run water yearlong although the north channel carries more water during base flows. The two channels are 300 feet apart at Site WF-4. Historic aerial photography indicates that the main river periodically shifts between the two channels and will probably continue doing so.

Rock rip-rap on the north channel of the West Fork.

Recommendation: Periodically check the "island" between the two channels to determine if active headcutting is occurring. If the north channel ever does cut through to the south channel, it will most likely be due to a headcut(s), not bank erosion.

Site WF-5 Stream Crossing – Private Bridge (Map) **Priority: No Action**

(West Fork Stillwater River - Map #1)

Steel beam bridge with concrete abutments. The bridge has a 50 foot free span across the north channel on a braided section of river. It provides access to a house built between the north and south river channels.

Site WF-6 Small Tracts – Berkley Subdivision **Priority: High**

(West Fork Stillwater River - Map #2)

There are 11 small tracts in the Berkley Subdivision along 0.5 miles of the West Fork that were developed in the 1960s and 1970s. All tracts are less than 5 acres and have river frontage on the north floodplain. Most houses are located on the river with some form of bank stabilization (rock rip-rap and retaining walls) and/or flood dike. The bank stabilization and dikes were typically constructed with large round boulders and smaller cobbles. Most houses built on the low floodplain are less than 50 feet from the river. The tracts have either small in-river irrigation pumps or shallow wells for domestic use. Riparian vegetation has been cleared to varying degrees to accommodate landscaping.

Individual small tract impacts to channel stability, in-stream flow, and water quality are usually minimal, but cumulatively they pose a significant risk to the West Fork Stillwater River.

House built on the floodplain next to the river's edge. A retaining wall and rip-rap have been built to minimize damage incurred during high water.

Recommendation: Develop and implement a small tract outreach and assistance program to help tract owners better understand how to minimize their impacts on the river. The program would include site-specific information on noxious weed management, water rights, septic maintenance, suitable building locations, riparian vegetation, and basic river dynamics.

Site WF-7 Hillside Slump **Priority: High**

(West Fork Stillwater River - Map #2)

Slow moving hillside slump on the south side of the river. The surface of the landslide is hummocky with concentric swales and ridges. The toe of the slump borders the river.

The hillside has glacial deposits overlying shale/sandstone bedrock. Natural precipitation and irrigation water can quickly percolate through the surface glacial materials (very fine clay to large boulders) eventually reaching the underlying shale or sandstone bedrock interface. The steep slope and water saturation of the glacial/bedrock interface may spur mass movement and unstable conditions. This scenario is common in the glaciated Stillwater and Boulder River drainages.

Most hillside slumping is relatively slow moving. The 1951 aerial photography shows little change over the last 60 years. Since the slump is slow moving, the river has the ability to remove the material as it reaches the river. That is not to say under saturated conditions, and perhaps in conjunction with seismic activity, the potential for abrupt and mass movement couldn't happen. It is unlikely, but certainly possible. The Berkley Subdivision tracts on the opposite side of the river could be threatened if such a scenario were to happen.

There are irrigation ditches and irrigated hayland/pasture on the bench above the hillside slump. During the summer, irrigation water may be contributing surface and ground water to the area. Two ephemeral coulees direct run-off from snow melt, high rainfall events, and irrigation waste water to a shallow depression upslope of the slump and eventually to the slump itself.

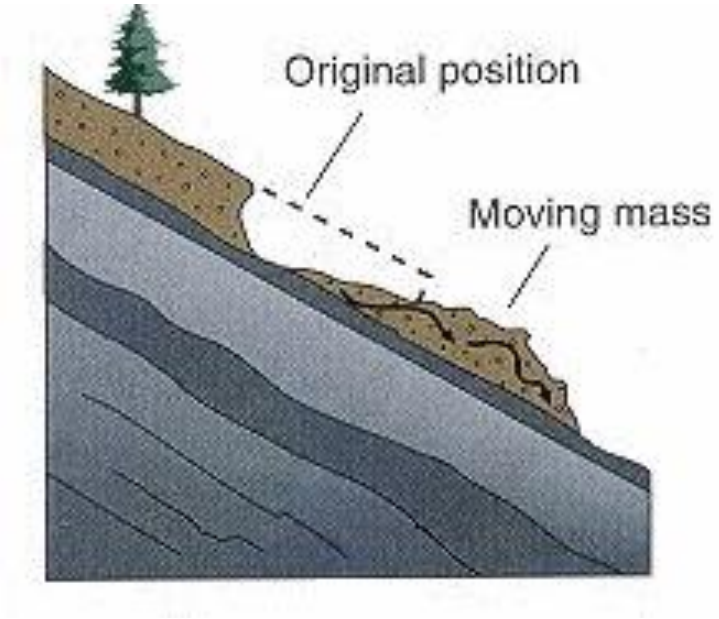


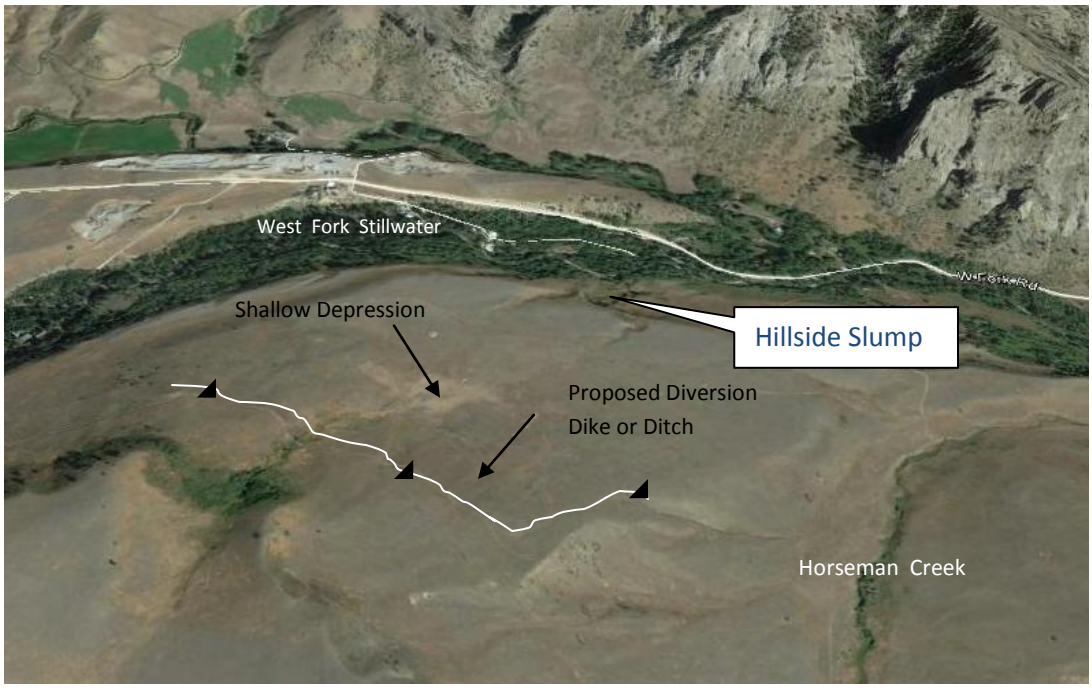
Diagram showing how unconsolidated glacial deposits can "slide" on the underlying bedrock interface. This occurs most often on steep slopes and under saturated conditions.

Hummocky surface on the hillside slump at Site WF-7.

Recommendation: There is no assurance that the slump will not move in the future. It is a natural phenomenon common to the intermountain glaciated valleys of southcentral Montana. To slow future movement, the most cost effective option is to minimize water saturation in the slump area. All run-off from snow melt, heavy rains, and irrigation water should be diverted away from the slump area. The map below shows a possible route to divert run-off and irrigation water to Horseman Creek. The timing and frequency of flood irrigation on the bench above the slump is important in minimizing soil saturation.

For the water diverted to Horseman Creek, find a stable waterway off the bench that will not erode. If there are augmented flows in Horseman Creek, the recommendation for Site WF-11 to divert Horseman Creek away from the proposed rip-rapped West Fork bend becomes even more important.

There are firms who specialize in hillside stabilization, usually from states like California. They often employ geotechnical options that may include drainage, retaining walls, and slump removal. These options are expensive and not always guaranteed.



Site WF-8 Bank Stabilization – Rock Rip-Rap **Priority: No Action**

(West Fork Stillwater River - Map #2)

Rock rip-rap along 120 feet of the West Fork Road. The rip-rap was constructed with round boulders and cobbles of various sizes. Shrubs and small trees are growing up through the rip-rap.

The county road bottlenecks this section of river putting pressure on the road grade. The rip-rap is currently intact, but should be re-evaluated following every high water event.

Reach 1: Site WF-1 to WF-8

(West Fork Stillwater River – Map #'s 1 and 2)

Channel Characteristics: The river channel between Sites WF-1 and WF-8 is a high gradient, boulder dominated, step/pool channel. Channel gradient ranges from 4.9% to 2.8%, averaging 3.7%. Most of this reach is single threaded with short segments of braided channels. The river corridor averages 250 feet on the upper end and gradually widens to as much as 620 feet. Bank stabilization and floodplain dikes along the Berkley Subdivision have restricted the river's access to its historic floodplain. At the lower end of the reach, the West Fork county road bottlenecks the floodplain to 110 feet, 20% of its original width.

Naturally armored, boulder strewn river downstream from Site WF-5. The riparian vegetation along the channel is generally in excellent condition.

Riparian Characteristics: The riparian corridor overstory is dominated by a mix of black cottonwood and conifers. The primary understory species consist of aspen, snowberry, spirea, and russet buffaloberry. The riparian plant community is in excellent condition except where the riparian vegetation has been cleared to accommodate small tract housing and landscaping. Very few noxious weeds were noted along this section of river.

Site WF-9 Stream Crossing – Private Bridge **Priority: No Action**

(West Fork Stillwater River - Map #2)

Steel railcar bridge resting on concrete abutments. The bridge has a 50 foot free span with 5 feet of freeboard between the bridge beams and the river channel. The bridge provides landowner access to the south side of the river off the West Fork Road. The bridge is in good condition.

Site WF-10 Irrigation Structure **Priority: Medium**

(West Fork Stillwater River - Map #2)

Old metal irrigation turnout and check structure located on the north bank of a secondary channel next to the West Fork Road. The structure, not used in over 20 years, once irrigated a 3 – 4 acre field down-valley. The turnout is an 18 inch diameter steel pipe with a grate to trap woody debris. The inlet has no water control gate. The steel plate check structure extends 20 feet across the channel and has a 2 foot drop. The conveyance ditch is filled in and no longer functional.

Old irrigation diversion: steel pipe turnout in the foreground and a steel plate check structure across the channel.

Recommendation: Remove the cross-channel check structure.

Site WF-11 Channel Stabilization – Potential Avulsion **Priority: High**

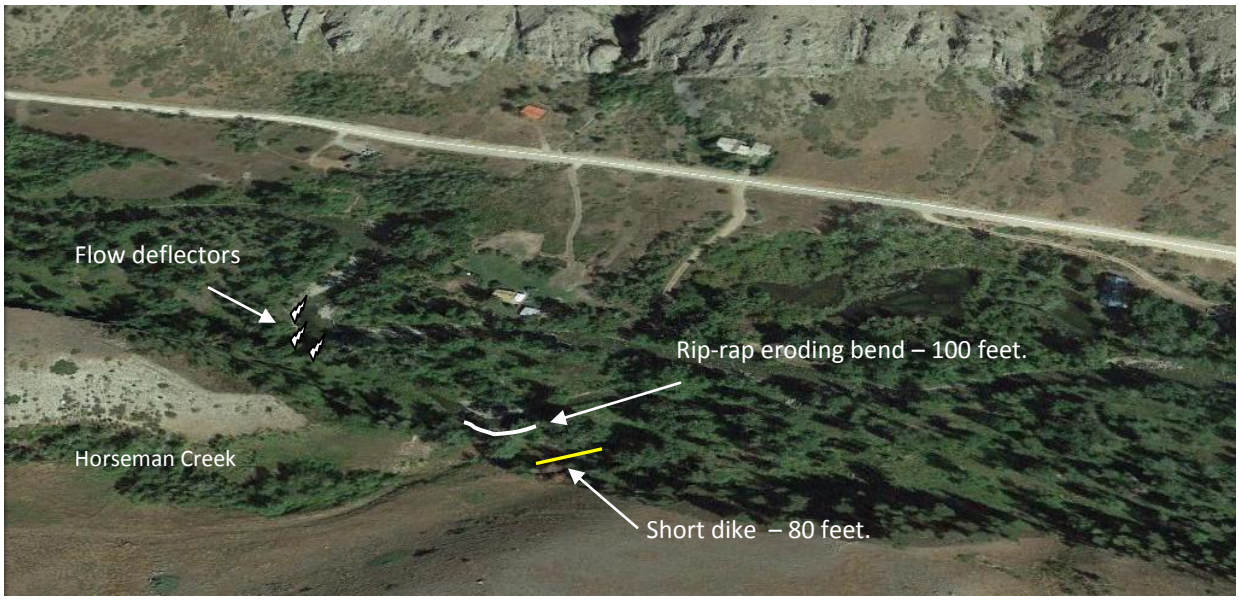
(West Fork Stillwater River - Map #2)

The West Fork River could recapture its old channel. The West Fork splits into 2 channels upstream from Site WF-11. The south channel carries less flow than the north channel. Horseman Creek (ephemeral coulee) enters the West Fork near an eroding bend on the south channel. If the bend continues to erode down-valley and/or if out-of-bank flood water creates a series of headcuts, the West Fork could recapture its old channel. The old channel tracks southeast entering the Stillwater River at Nye/Carter's Camp nearly 0.7 miles upstream from the current confluence of the West Fork. The West Fork hasn't followed its old channel in over 110 years. 1903 GLO maps show the river in its current location. No headcuts were found during the assessment. A preliminary survey indicates that out-of-bank flood water currently re-enters the West Fork and does not access the old channel.

Eroding bend on the south channel is shown in the background. An old river channel trace begins not far down-valley from this bend. Horseman Creek enters the West Fork on the right.

Recommendation: It is not likely that the river will revert to its old channel; however, the following recommendations would provide additional assurances that it will remain where it currently is:

1) Incorporate 2 – 3 small flow deflectors into the existing bank rip-rap upstream from the split channel to "encourage" the main flow to remain in the north channel.
2) Shape the eroding bend (100 feet) on the south channel to a 3:1 slope and armor with angular rock rip-rap. Form a low berm along the bend to divert Horseman Creek run-off away from the bank.
3) Construct a low dike (3 feet high x 80 feet long) about 100 feet down-valley from Horseman Creek to assure out-of-bank flows are directed towards the existing West Fork channel and away from the old channel.



Site WF-12 Small Tracts – High Chaparral and West Fork Subdivisions **Priority: High**
(West Fork Stillwater River - Map #2)
There are 11 small tracts in the Chaparral and West Fork Subdivisions along 1.0 mile of the West Fork. Each tract has river frontage on the north floodplain. The tracts range in size from 0.6 – 10 acres. Several houses were built on the low floodplain less than 50 feet from the river's edge and under 5 feet vertical difference between the house foundations and river. Bank stabilization (rock rip-rap, retaining walls, etc.) is associated with most tracts. Many have either small in-river irrigation pumps or shallow wells for domestic use. The riparian vegetation has been partially cleared to accommodate landscaping.

Individual small tract impacts to channel stability, in-stream flow, and water quality are usually minimal, but cumulatively they pose a significant risk to the West Fork Stillwater River.

House built on the low floodplain next to the river.

Recommendation: Develop and implement a small tract outreach and assistance program to help tract owners better understand how to minimize their impacts on the river. The program would

include site-specific information on noxious weed management, water rights, septic maintenance, suitable building locations, riparian vegetation, and basic river dynamics.

Site WF-13 Irrigation Structure **Priority: No Action**

(West Fork Stillwater River - Map #2)

Steel irrigation headgate located on a small channel at the downstream end of a island. The gate was installed about 8 years ago. The south channel runs a fraction of the flow compared to the main channel and is periodically dredged to maintain an adequate flow to the headgate. Hand-placed rocks are sometime used to check water into the headgate during low flows.

Site WF-14 Irrigation Structure – Countryman Ditch **Priority: No Action**

(West Fork Stillwater River - Map #2)

Irrigation turnout on the north bank next to a parking area on state land. The turnout/canal is used to convey water to irrigated lands over a mile away to the northeast. There is a low-head cross channel rock check at the canal inlet and a concrete water control structure about 200 feet down the canal. The irrigation system hasn't been used in over 12 years and would require major canal and infrastructure work before becoming operational. Some water rights associated with this canal have been transferred to a pump site on the Stillwater River (Site SW-37).

Site WF-15 Irrigation Structure **Priority: No Action**

(West Fork Stillwater River - Map #3)

Steel irrigation headgate located on the north bank. This headgate conveys water to hay fields north of the West Fork and east of Highway 420. When flows are low in the late summer, an irrigation canvas is draped across the channel to check sufficient flows into the headgate.

Site WF-16 Irrigation Structure **Priority: No Action**

(West Fork Stillwater River - Map #3)

Small tin irrigation headgate located on the south channel of the West Fork River. The river splits 200 feet upstream. Concrete jersey barriers (5 – 6) are placed in the channel during low flows to provide sufficient water to the headgate. They are removed in the fall after the irrigation season. The structure provides irrigation water to a pasture and hay fields east of the Stillwater River Road.

Site WF-17 Stream Crossing – South County Bridge **Priority: No Action**

(West Fork Stillwater River - Map #3)

Concrete bridge on the Stillwater River Road that spans the south channel. The West Fork splits into two channels about 180 feet upstream from the county road. The bridge has an 80 foot span with concrete abutments. Cobble rip-rap has been placed on the abutment toes. The bridge is about 10 years old and was relocated about 800 feet upstream from its previous location.

Site WF-18 Stream Crossing – North County Bridge **Priority: No Action**

(West Fork Stillwater River - Map #3)

Concrete bridge on the Stillwater River Road that crosses the north channel. It is located 100 feet north of the south bridge (Site WF-17). The West Fork splits into two channels about 600 feet upstream from the county road although the channels are nearly rejoined about 180 feet from the road. The bridge has an 80 foot span with concrete abutments. It is about 10 years old and was

relocated about 900 feet upstream from its previous location. There is 200 feet of angular and rounded rock rip-rap along the north-bank bend immediately downstream from the bridge.

Site WF-19 Small Tracts **Priority: High**

(West Fork Stillwater River - Map #3)

The river continues in two channels since its split near Site WF-16. Five small tracts are located on both channels (0.1 mile) downstream from the old bridge crossings. The tracts range in size from 1 – 3 acres. Three of the tracts have buildings located on the low floodplain next to the river. Bank stabilization (rock rip-rap and small jetties) is associated with the developed tracts. The riparian vegetation has been partially cleared to accommodate buildings and landscaping.

Individual small tract impacts to channel stability, in-stream flow, and water quality are minimal, but cumulatively they pose a significant risk to the West Fork Stillwater River.

House located on the low floodplain with rock rip-rap placed along the bank.

Recommendation: Develop and implement a small tract outreach and assistance program to help tract owners better understand how to minimize their impacts on the river. The program would include site-specific information on noxious weed management, water rights, septic maintenance, suitable building locations, riparian vegetation, and basic river dynamics.

Site WF-20 Irrigation Structure **Priority: No Action**

(West Fork Stillwater River - Map #3)

Irrigation headgate on the north bank of the West Fork River. The headgate has a concrete headwall and a metal wheel slide gate. The cross-channel check structure is constructed of large boulders that provide an additional 2 – 3 feet of head at the headgate. Concrete jersey barriers are used during late summer low flows to maintain head at the headgate. This structure is working very well. It provides an adequate volume of water to the headgate while allowing bedload and fish passage. Woody debris that hangs up on the rock check structure is occasionally burned. This type of structure serves as an example for large irrigation diversions on the Stillwater River.

Site WF-21 Bank Stabilization – Rock Rip-Rap **Priority: No Action**

(West Fork Stillwater River - Map #3)

Rock rip-rap placed along a south channel bank next to a pasture. It is about 220 feet long and consists of round cobbles. There is some minor scouring, but the rip-rap appears to be mostly intact. The 1951 aerial photography shows little bank movement over the last 62 years. There is no riparian vegetation along this bank.

Small pens upstream from the rip-rap are 30 – 40 feet from the river's edge. The landowner indicated that these pens will be moved in the near future. Downstream from Site WF-21, the river becomes depositional and highly sinuous for about 1,000 feet.

Reach 2: Site WF-8 to WF-21

(West Fork Stillwater River – Map #'s 2 and 3)

Channel Characteristics: The river channel between Sites WF-8 and WF-21 is a moderate gradient, cobble dominated channel. The channel gradient averages 1.8%. Most of the river along this reach is single threaded with short segments of braided channel. The width of the river corridor on the upper and lower thirds of the reach average about 600 feet. The middle third is narrower, ranging from 100 – 250 feet where the river runs through the West Fork's alluvial fan and enters the Stillwater River valley. Several historic channel traces are evident on this alluvial fan.

Most bank stabilization is associated with small tract developments and river crossings.

Single-threaded, cobble-lined channel with a densely vegetated floodplain. Photo taken near Site WF-13. The channel gradient gradually decreases as the West Fork approaches the Stillwater River.

Riparian Characteristics: The riparian corridor overstory is dominated by black cottonwood trees. The understory is a mix of snowberry, wild licorice, and smooth brome.

Spotted knapweed plants are thinly scattered along this reach becoming more prevalent downstream from the Stillwater River Road bridges.

4.3 Lodgepole Creek

The Lodgepole Creek assessment begins at the US Forest Service boundary (River Mile 4.7) and ends at its confluence with Limestone and Castle Creeks (River Mile 0.0). Lands along Lodgepole Creek are primarily in agricultural production. A county road parallels the length of the stream.

Site LP-1 Stream Crossing – Ford **Priority: No Action**

(Lodgepole Creek - Map #1)

Ford stream crossing (US Forest Service) located approximately 100 feet upstream from the Indian Creek confluence. The late 2013 summer flow in Lodgepole Creek was less than 0.5 cfs. The road and ford crossing are not maintained and only suitable for ATVs, horses, or hiking.

Site LP-2 Irrigation Structure - Inactive **Priority: No Action**

(Lodgepole Creek - Map #1)

Old concrete irrigation headgate/check structure located on north side of creek. The structure is no longer in use. The conveyance ditch washed out 600 feet downstream from the headgate. The structure is 6 feet above the downstream channel. It may serve as a barrier to fish passage.

Site LP-3 Stream Crossing – Ford **Priority: No Action**

(Lodgepole Creek - Map #1)

Ford stream crossing on county road. The 2011 flood washed out the culvert at this crossing. Out-of-bank flows followed the roadbed creating a scoured trench 2 – 3 feet deep and 8 feet across. Because of flood damage, the road was closed to vehicle use.

Site LP-4 Stream Crossing – Ford **Priority: High**

(Lodgepole Creek - Map #1)

Ford stream crossing on county road. The 2011 flood washed out the culverts and out-of-bank flows followed the roadbed creating a scoured trench 3 feet deep.

About 700 feet downstream from Site LP-4, the creek channel is less than 10 feet from the road. The creek will probably breach into the road during a future high water event causing additional damage. There is approximately 2,800 feet of road between Site LP-3 and downstream from LP-4 where the road is entrenched into the floodplain that will continue to be vulnerable to out-of-bank flows.

Between Sites LP-4 and LP-5, a large gravel depositional reach causes stream flows to go underground during late summer months.

Scoured county road between Sites LP-3 and LP-4 caused by the 2011 flood.

Recommendation:

1) To reduce impacts on the stream and minimize future road maintenance expenses, relocate 2,800 feet of county road off the low floodplain and onto the east terrace. This would eliminate on-going problems with the two crossings and continued scouring of the road. An agreement would be necessary between the landowner and the county for the new right-of-way.
2) If the road remains in the stream corridor, it is suggested that it be restricted to ATV and horse use.
3) In either situation, a series of small "kelly humps" constructed along the length of the road would direct high flows away from the entrenched road and back onto the adjacent floodplain.

Site LP-5 Irrigation Structure - Inactive **Priority: No Action**

(Lodgepole Creek - Map #1)

Old concrete irrigation structure located 50 feet upstream from a stream crossing (Site LP-6). The structure once delivered irrigation water to fields on the west side of the creek. The structure has washed out and is no longer functional. One wing wall is lying in the stream bed and another is deflecting flow towards the north bank causing minor bank erosion.

Site LP-6 Stream Crossing – Culvert **Priority: No Action**

(Lodgepole Creek - Map #1)

Stream crossing (5 x 6 foot CMP culvert) on Meyers Creek Road. This crossing provides public access to USFS lands. It was recently rebuilt, replacing the crossing washed out during the 2011 flood. Rock rip-rap lines both the inlet and outlet of the culvert.

Site LP-7 Stream Crossing – Ford **Priority: No Action**

(Lodgepole Creek - Map #1)

Private ford stream crossing accessing hay fields and pasture on the east side of creek. Upstream from the ford crossing, gravel deposition is causing the creek channel to widen. A number of eroding banks are a consequence of the stream being "pushed around" by these gravel deposits.

Site LP-8 Floodplain Dike **Priority: No Action**

(Lodgepole Creek - Map #1)

Small gravel dike along the east bank. The dike was pushed up during the 2011 flood to prevent over-bank flow from reaching a house on the edge of the east floodplain. The dike averages 3 feet high and is approximately 50 feet long. It appears to be an emergency action that provided short-term flood protection.

Site LP-9 Stream Crossing – Bridge **Priority: No Action**

(Lodgepole Creek - Map #1)

Private stream crossing is a 20 foot steel bridge (10 foot effective span). This bridge provides access to a house on the east side of the creek. The bridge beams have 4 – 5 feet freeboard between the bridge and creek. Large boulders serve as the west bank bridge abutment. The bridge was built in a good location: a stable, straight section of the creek.

Site LP-10 Floodplain Dike **Priority: No Action**

(Lodgepole Creek - Map #1)

Small gravel dike on the west bank. A 3 – 4 foot dike was pushed up during the 2011 flood to prevent over-bank flows from damaging a barn and corrals next to the creek. The dike extends downstream several hundred feet, paralleling the west channel bank. It ranges in height from 0 – 5 feet and appears to be an emergency action that provided short-term flood protection.

Site LP-11 Stream Crossing – Bridge **Priority: No Action**

(Lodgepole Creek - Map #1)

Private bridge crossing. This bridge provides access to a house and fields on the east side of the creek.

Reach 1: Site LP-1 to LP-11

(Lodgepole Creek – Map #1)

Channel Characteristics: The creek channel is vertically entrenched up to 3 feet deep along most of this reach. Minor bank erosion has occurred because of the channel downcutting. Other sections of this reach have a relatively flat gradient where gravel deposits have filled the channel causing the creek to become wide and shallow.

Short segments of bank stabilization have been placed at the bridge crossings. Gravel dikes pushed up during the 2011 flood are no longer effective due to high water breaches and livestock trampling.

Several small springs feed into Lodgepole Creek along this reach. Meyers Creek enters Lodgepole Creek approximately 700 feet downstream from Site LP-11.

Lodgepole Creek downstream from Site LP-7. The channel is entrenched 2 – 3 feet creating some minor bank erosion. Algae covers much of the channel bottom in late summer.

Riparian Characteristics: The riparian vegetation on the upper reach (Sites LP-1 to LP-4) is primarily conifers (Engelmann spruce) with a dense understory of willows and grass. The creek channel is filled with woody debris. Further downstream from Sites LP-4 to LP-11, the riparian vegetation transitions to a mix of black cottonwood and conifers. The riparian corridor varies from large dense patches of trees and shrubs to a narrow band of scattered trees and shrubs. The 1951 aerial photography indicates that there was less riparian vegetation along the stream 60 years ago than there is now.

Land between Sites LP-11 to LP-12 was not included in the Lodgepole Creek assessment.

Site LP-12 Floodplain Dike **Priority: No Action**

(Lodgepole Creek - Map #2)

Small gravel dike along the southwest stream bank. The dike was pushed up during the 2011 flood to prevent over-bank flows from crossing an adjacent hay field. The dike is 1 – 3 feet high and approximately 300 feet long.

Site LP-13 Stream Crossing – Ford **Priority: No Action**

(Lodgepole Creek - Map #2)

Private ford stream crossing to access hayland and pasture on the east side of creek. The crossing is in a good location where the channel is shallow and straight with a firm bottom. This site is close to where the Lodgepole Creek Road once crossed the creek in the early part of the 20th century (Ref: 1907 GLO map).

Site LP-14 Corrals **Priority: Medium**

(Lodgepole Creek - Map #2)

Small corral system/water gap located on west stream bank. Snow melt and heavy rain run-off may carry nutrients from the corral's manure pack to the creek. The landowner is currently working with the local NRCS office to relocate the corrals/buildings off the creek and develop livestock water.

USGS maps show this site to be the old town of Limestone, a mining community situated along Lodgepole Creek at the foot of Limestone Butte, for which the town was named. The post office

operated at Limestone from 1910 to 1953. Today, Limestone is a ranch headquarters with a number of the old town buildings still standing, including the former grocery store and post office.

Small corral system located on Lodgepole Creek, downstream from the old town of Limestone.

Recommendation: Landowner is actively working with the local NRCS office to relocate the corrals and develop livestock water on higher ground.

Site LP-15 Stream Crossing – Culvert **Priority: Medium**

(Lodgepole Creek - Map #2)

Private stream crossing (5 foot diameter x 18 foot long CMP culvert). The crossing is located on a bend with rock rip-rap on both the inlet and outlet faces. The culvert serves as a channel restriction during high flows forcing water out of the creek and across the east pasture. There is a 2 – 3 foot high drop at the outlet.

Culvert stream crossing on Lodgepole Creek serving as a channel restriction.

Recommendation: Downstream from the culvert crossing, there is a straight section of Lodgepole Creek that is entrenched about 8 feet deep. Constructing a wood beam bridge (60 foot span) at this location would eliminate the current channel restriction and provide increased capacity to pass high flows. Access across the creek would be more reliable and long-term maintenance costs would be less.

Site LP-16 Stream Crossing – Bridge **Priority: No Action**

(Lodgepole Creek - Map #2)

Private bridge crossing with a 24 foot span originally installed to access a timber harvest operation on the east side of creek. The bridge beams are 2 feet above the channel. Previous high water has bypassed this bridge without causing significant damage. About 110 feet upstream from the bridge, there is 80 feet of loosely-placed rock rip-rap at the toe of the county road. The road surface has been cut into the west side hill and sits 10 – 12 feet above the stream channel.

Site LP-17 Bank Stabilization – Rock Rip-Rap **Priority: No Action**

(Lodgepole Creek - Map #2)

Two sections of blanket rock rip-rap have been placed along the county road. The upstream rip-rap is 100 feet long and the downstream rip-rap is 80 feet long. Both sections of rip-rap are intact.

Site LP-18 Bank Stabilization – Rock Rip-Rap **Priority: No Action**

(Lodgepole Creek - Map #2)

Rock rip-rap along west bank close to the county road. The armored bank, approximately 80 feet long, was installed to prevent the stream from eroding into the toe of the county road. The rock rip-rap was well placed and is intact.

Site LP-19 Stream Crossing – Culvert **Priority: Medium**

(Lodgepole Creek - Map #2)

Stream crossing (5 foot x 6 foot arch culvert – 30 feet long) on the Meyers Creek Road. The crossing is in a poor location forcing the creek to make a sharp 90° bend before entering the culvert. There is a 20 foot section of rock rip-rap on the bend just above the entrance of the culvert crossing. The culvert does not have capacity to pass flood waters. There is 3 – 4 feet of channel freeboard before high flows go out-of-bank and threaten the county road down-valley. The 1951 aerial photo shows an old stream meander east of the crossing that once directed the stream straight into the culvert crossing. The meander has since been cut-off changing the stream alignment to a right angle.

Culvert crossing located on a sharp bend. The culvert does not have the capacity to pass flood waters.

Recommendation: Move the stream crossing down-valley about 170 feet to where the road crosses the creek at a 90° angle. This would require about 250 feet of channel construction and a new crossing, preferably a bridge. A less costly approach would be to install a second culvert at the

current location and realign the culverts in a more southerly direction. An additional high-water culvert may be needed down the road to accommodate over-bank flows.

Reach 2: Site LP-12 to LP-19

(Lodgepole Creek – Map #2)

Channel Characteristics: The floodplain along this reach is narrow, ranging from less than 100 – 550 feet. The county road borders the valley on the west hillside above the floodplain. The county road downstream of Site LP-19 serves as a cross-valley restriction during large flood events.

Some channel straightening has occurred over the last 50 years creating channel entrenchment, especially downstream of Site LP-15. Overall, the channel is fairly stable with a few sections of actively eroding stream bank. Most bank stabilization along this reach occurs where the stream butts up against the county road between Sites LP-16 and LP-19.

Several large springs enter Lodgepole Creek. One exceptionally large spring, located on the west hillside between Sites LP-15 and LP-16, contributes 1,400 – 6,000 gpm to Lodgepole Creek. In late summer, this spring more than doubles the volume of water in the creek. This spring is partially captured by irrigation ditches conveying water up and down the valley.

Lodgepole Creek upstream of Site LP-5. Riparian trees and shrubs are intermittent along this reach.

Riparian Characteristics: The stream corridor on the upper reach is mostly pasture grasses with occasional willow patches. Willows become more common on the lower end of the reach. The 1951 aerial photography shows less riparian vegetation along the stream than what there is now. Prior to settlement, this valley likely had dense stands of willow along the stream and across the floodplain. Narrow valleys, like Lodgepole Creek, make it a challenge to raise livestock and not have long-term impacts on the riparian vegetation.

RM 0.0 to RM 0.9

The landowner along this section of Lodgepole Creek chose not to participate in the stream assessment.

4.4 Limestone Creek

The Limestone Creek assessment begins at the confluence of Lodgepole Creek and Castle Creek (River Mile 2.1) and ends at its confluence with the West Fork Stillwater River (River Mile 0.0). The land use along Limestone Creek is primarily agricultural (hay land and pasture). The exception is two non-agricultural tracts on the lower end of Limestone Creek.

RM 2.5 to RM 2.1

The landowner along this section of Limestone Creek chose not to participate in the stream assessment.

Site LS-1 Irrigation Structure **Priority: No Action**

(Limestone Creek - Map #1)

Concrete irrigation structure on the south bank. The structure has board checks to direct irrigation water either back to the creek or into an irrigation lateral. Minor scouring was noted beneath the outlet footings, but overall the structure is in good condition. The headgate that conveys water to this structure is located 350 feet upstream on the south bank.

Upstream of the structure, three sections of rock rip-rap line both sides of the creek and range in length from 20 – 50 feet. A series of small rock jetties extend into the creek along 90 feet of the south bank downstream from the structure. All bank stabilization measures appear to be intact and functioning as intended.

Site LS-2 Stream Crossing – Bridge **Priority: No Action**

(Limestone Creek - Map #1)

Private bridge crossing that provides access to the north side of creek. The wood beam bridge has an 18 foot span resting on concrete pier abutments. The south abutment encroaches into the active channel 5 – 6 feet creating a slight channel restriction. The bridge does not appear to be used very often.

Upstream from the bridge, short segments of rock rip-rap line both sides of the creek and range in length from 50 – 80 feet. Small rock jetties extend into the creek downstream from the bridge. All appear to be intact and functional.

Site LS-3 Bank Erosion **Priority: No Action**

(Limestone Creek - Map #1)

Minor bank erosion on the south bank. If the erosion continues, it may eventually threaten an adjacent farm road and hay field. A dense stand of grass along this bank is slowing the erosion.

The creek is attempting to re-establish channel length lost when the creek was straightened prior to 1951. Most outside bends between Sites LS-2 and LS-3 are lined with either rock rip-rap or jetties constructed with large round boulders. All bank stabilization features are intact.

In the first half of the 20th century, the creek was probably moved to the north edge of the valley to accommodate hay production. 1907 GLO maps show the creek meandering further to the south.

Site LS-4 Stream Crossing – Bridge **Priority: Low**

(Limestone Creek - Map #1)

Private bridge crossing at the ranch buildings. The wood beam bridge has a 16 foot free span sitting on concrete abutments. The bridge is located on a bend. During high water, shear stress on the south abutment has caused minor scouring of the abutment footings. The north road approach restricts high flow access to the historic floodplain.

Bridge crossing at ranch buildings.

Recommendation:

1) Repair the scoured footing on the south abutment.
2) When the bridge is ready to be replaced, consider moving it upstream about 100 feet to a straighter, more stable section of channel. Increase the bridge span to 20 feet giving it more capacity to pass high flows.

Site LS-5 Corrals **Priority: High**

(Limestone Creek - Map #1)

Small corral system with two water gaps on south side of creek. A 10 – 15 foot wide vegetative buffer separates the corrals and the stream. During snow melt and heavy rain run-off, elevated concentrations of nutrients from the manure pack may drain into the creek.

Small corral system located next to Limestone Creek.

Recommendation: The landowner worked with the local NRCS office to make changes to the corral system.

Site LS-6 Stream Crossing – Ford **Priority: No Action**

(Limestone Creek - Map #1)

Ford crossing located on the downstream end of the corrals at Site LS-5. The crossing is in a good location where the creek is straight and stable. A small foot/ATV bridge spans the creek 15 feet upstream from the ford crossing.

Site LS-7 Irrigation Headgate/Check Structure **Priority: No Action**

(Limestone Creek - Map #1)

Irrigation headgate and cross-channel check structure on the south bank. The cross-channel structure uses boards to raise the water level up to 1 ½ feet. The headgate has a steel water control gate. A long concrete block, placed in the channel upstream from the structure, diverts flow toward the gate. The structure is in good condition. Upstream, concrete slabs and rock rip-rap line the north bank. Downstream, 80 feet of rock rip-rap line the south bank.

Site LS-8 Hillside Sloughing **Priority: No Action**

(Limestone Creek - Map #1)

Hillside sloughing along north terrace bank. Limestone Creek is undercutting a hillside (glacial deposits) that is actively sloughing. The stream can easily transport the volume of gravel and sediment entering the channel.

Site LS-9 Stream Crossing – Bridge **Priority: No Action**

(Limestone Creek - Map #1)

Private bridge crossing that provides access to the east side of creek. The wood bridge has a 16 foot span resting on concrete abutments. It is elevated 6 feet above the channel bottom and has sufficient capacity to pass most high water flows. The bridge is in good condition.

Reach 1: Site LS-1 to LS-9

(Limestone Creek – Map #1)

Channel Characteristics: The floodplain along Limestone Creek averages about 600 feet wide. The creek follows the north fringe of the valley, except where it crosses to the south side at Site LS-9. Most of the valley bottom is in irrigated hay production. A farm road follows the south side of the creek. Prior to 1950, sections of the creek channel were straightened to accommodate hay production. Old aerial photos show channel traces in the hay fields. The stream currently has less length, fewer meanders, and a steeper grade (1.6 %) than pre-settlement. Several bends in the creek are armored with either rock rip-rap or rock jetties. The channel is entrenched 3 to 8 feet.

Looking downstream from Site LS-7, the stream runs east along the north fringe of the valley. A farm road parallels the creek channel.

Riparian Characteristics: A 15 – 25 foot band of riparian vegetation along the south bank separates the creek from the farm road. The upper riparian buffer is primarily pasture grasses with intermittent patches of willows and alders. Downstream from the ranch headquarters, the riparian band becomes more dense and continuous. The 1951 aerial photography shows less riparian vegetation along the stream than what is there now. Prior to settlement, this narrow valley likely had a dense stand of willow/alders with multiple channels and beaver activity across the entire floodplain.

Recommendation: If the fisheries are a priority with current or future landowners, several habitat improvements should be considered such as:

1) Simple inexpensive in-channel rock/log habitat structures that would increase diversity of habitat.
2) Planting willow cuttings along the stream where the riparian buffer is open.
3) Re-establishing additional length and meander to the stream.

Site LS-10 Turnout/Diversion Structure **Priority: Low**

(Limestone Creek – Map #1)

Small turnout structure and cross-channel rock diversion on the south bank. The turnout is a water control gate attached to a pipe that conveys water to an off-stream pond. There is no headwall. Floating debris tends to build up on the rocks next to the gate. The pond is partially silted in and no longer holds fish.

Cross-channel rock diversion with a small slide gate on the south bank that delivers water to an off-stream pond.

Recommendation: If the pond is used again, the diversion would be more effective if the rocks were replaced with portable concrete blocks. It would take three blocks to divert sufficient water into the headgate. The blocks would be placed in the channel during late summer low flows and removed before winter. The gate should be attached to a concrete or metal headwall.

Site LS-11 Stream Crossing – Bridge **Priority: No Action**

(Limestone Creek – Map #1)

Private bridge crossing providing access to a house and outbuildings on the north side of creek. The wood beam bridge has a 20 foot free span resting on concrete abutments. A 125 foot long rock/concrete retaining wall runs along the north bank between the bridge and house. A foot bridge crosses the creek on the upper end of the retaining wall. An additional 40 feet of rock rip-rap line the north bank downstream from the bridge.

Site LS-12 Irrigation Structure **Priority: Medium**

(Limestone Creek – Map #1)

The concrete irrigation structure is located 400 feet down an open ditch above the south bank. It is a 3-way structure that returns irrigation water to the creek (board check), turns water out into an irrigation lateral (slide gate), or passes water down the main ditch (board check). The structure appears to be new and provides irrigation water to 3 – 4 acres of pasture on the south floodplain. The entrance to the open ditch does not have a gate to control the amount of water entering the ditch. High flows and floating debris may be a recurring problem for this structure.

Three-way concrete irrigation structure on the side of the creek.

Recommendation: Construct a water control structure at the entrance of the open ditch to prevent bedload and floating debris from clogging the headgate.

Site LS-13 Bank Stabilization – Rock Rip-Rap **Priority: No Action**

(Limestone Creek – Map #1)

Rock rip-rap on the north bank approximately 200 feet long. The cobble rip-rap is preventing the stream from migrating towards a house on the north bank. A foot bridge spans the creek near the house. Some riparian clearing has occurred on the north bank to accommodate landscaping. The south bank has a dense and healthy riparian plant community.

Site LS-14 Stream Crossing – Bridge **Priority: No Action**

(Limestone Creek – Map #1)

Private bridge crossing that provides access to a house at Site LS-13 on the north side of creek. The railroad car bridge, located on a straight section of stream, has a 30 foot span with 6 feet of freeboard between the bridge and creek. There are no bridge abutments making it potentially vulnerable to high water scour. Rock rip-rap lines 180 feet of the north bank, upstream from the bridge.

Site LS-15 Stream Crossing – Bridge **Priority: No Action**

(Limestone Creek – Map #1)

Public bridge crossing on the West Fork Road. The bridge is located about 60 feet upstream from Limestone Creek's confluence with the West Fork Stillwater River. The concrete bridge has a 50 foot span resting on concrete abutments faced with rock. The bridge beams are 6 feet above the channel bottom.

A small tract with a house and landscaped yard is located upstream from the bridge on the northeast floodplain. A large pond was constructed on the opposite floodplain with an elevated berm between the pond and Limestone Creek.

Reach 2: Site LS-10 to LS-15

(Limestone Creek – Map #1)

Channel Characteristics: The channel is naturally armored with gravel and cobbles which makes it relatively stable with minimal bank erosion. Bank stabilization (rock rip-rap and retaining walls) is normally associated with houses built next to the creek. The average channel gradient is 2.5%

Sheep Creek enters Limestone Creek from the north near Site LS-11. Sheep Creek runs water during short-term run-off events. The run-off is usually captured by an irrigation ditch before reaching Limestone Creek.

Limestone Creek downstream from Site LS-12. Riparian vegetation along the stream is intermittent.

Riparian Characteristics: This reach has a riparian corridor that ranges from 50 – 300 feet wide. There are short segments void of riparian vegetation. The riparian overstory is dominated by black cottonwood trees. Understory species include thinleaf alder, water birch, yellow willow, snowberry, and chokecherry. The vegetative understory varies in density depending on livestock and wildlife uses.

4.5 Little Rocky Creek

The Little Rocky Creek assessment begins at Highway 419 (River Mile 2.3) and ends at its confluence with the Stillwater River (River Mile 0.0). The upper 0.9 miles of Little Rocky Creek have remained in traditional agriculture. The lower 1.4 miles have been subdivided into 20 + acre tracts on both sides of the creek (Spreading Winge Subdivision). Currently, less than half of the tracts are developed.

Site LR-1 Stream Crossing – Bridge **Priority: No Action**

(Little Rocky Creek – Map #1)

Highway 419 concrete bridge over Little Rocky Creek. The bridge is a concrete "box" 12 feet wide and 10 feet high.

Site LR-2 Domestic Sump/Pump & Bank Stabilization - Rock Rip-Rap **Priority: No Action**

(Little Rocky Creek – Map #1)

The sump is a 5 X 5 foot concrete box buried on the east bank of the creek encasing a pump that provides water to nearby houses/outbuildings. The sump is located half way up the bank along an entrenched creek channel (8 – 10 feet). Rock rip-rap has been loosely placed around the sump and continues downstream protecting three buildings less than 20 feet from the upper bank. Minor scouring is occurring on the upstream side of the sump box.

Site LR-3 Stream Crossing – Bridge **Priority: Low**

(Little Rocky Creek – Map #1)

Private bridge access to ranch outbuildings and hay fields on the east side of the creek. The steel railcar bridge has an 18 foot free span resting on rock/concrete slab abutments. Minor scouring is occurring on the upstream side of the east abutment. There is 4 feet of freeboard between the bridge beams and the creek. The bridge approaches are not elevated and do not restrict out-of-bank flow. If the bridge plugs with debris, out-of-bank flows could affect a house (Site LR-4) about 120 feet away. There is a shallow swale on the west floodplain that may direct flows towards the house.

Bridge crossing provides access to ranch buildings and fields on the east side of the creek.

Recommendation: When the bridge is repaired or replaced, extend the span to accommodate high flows and lessen the possibility of the bridge plugging with debris.

Site LR-4 Bank Stabilization – Rock Rip-Rap **Priority: No Action**

(Little Rocky Creek – Map #1)

100 feet of cobble rock rip-rap loosely placed along a bend on the west bank. A house and deck have been built on the adjacent floodplain about 10 feet away from the armored bank. The rip-rap is currently intact, but because of the sharp bend and small cobbles, it is vulnerable to scour and may require periodic maintenance to stay functional.

Downstream from Site LR-4, 30 feet of large boulder rip-rap line the east bank adjacent to a tin shed. This site is part of an old corral system that is no longer in use and is slowly re-vegetating.

Site LR-5 Stream Crossing – Bridge **Priority: Medium**

(Little Rocky Creek – Map #1)

Private bridge crossing on Little Rocky Creek Road that is the primary access to small tracts on the west side of the creek. The steel beam bridge has a 30 foot span and 4 feet of freeboard between the bridge beams and the channel. The bridge has no abutments. Bank scour is occurring where the bridge rests on the ground. A ford crossing is located 20 feet downstream from the bridge.

Bridge crossing on Little Rock Creek Road. The bridge rests on the ground and may be vulnerable to high flows.

Recommendation: This bridge provides an important access for landowners and should be replaced with a more substantial bridge that is wider, longer, and has solid abutments (concrete or timber). A more reliable bridge would alleviate the necessity of a downstream ford crossing.

Reach 1

(Little Rocky Creek – Map #1)

Reach Description: Reach 1 extends 0.5 miles from the Highway 419 bridge crossing (Site LR-1) to the upstream boundary of the Spreading Winge Subdivision. This reach is primarily in agricultural use with houses and ranch outbuildings located on both sides of the stream.

Sites LR-1 through LR-5 are located in Reach 1.

Channel Characteristics: The creek is entrenched up to 8 feet deep on the upper end. It gradually becomes less entrenched downstream (3 – 6 feet). During the 2011 flood, 1 – 2 feet of vertical scour occurred. Within the entrenched channel, the creek is attempting to develop an inset floodplain. This is the reason for the active bank erosion along this reach.

The channel bottom is a mix of silt and small gravel. The average reach gradient is 1.3%. Downstream from Site LR-5, the stream corridor/floodplain becomes wider with a flatter gradient and more sinuous channel. Small debris jams and old beaver dams (0.5 – 3 feet high) create short backwater sections.

The mouth of Prairie Dog Creek enters Little Rocky Creek from the south between Sites LR-2 and LR-3. The Prairie Dog Creek channel is entrenched to the level of Little Rocky Creek. Its flow was about 0.5 cfs in early October 2013.

Old corral system downstream from Site LR-4. The stream channel is relatively wide and shallow from previous use. With the current management, the channel is beginning to stabilize.

Riparian Characteristics: The riparian corridor averages 80 feet wide, upstream from Site LR-5. Black cottonwood trees are the dominant overstory with an understory of chokecherry, yellow willow, and snowberry. The riparian vegetation is generally in good condition.

Downstream from Site LR-5, the riparian corridor widens to as much as 220 feet. Black cottonwood trees are replaced by a dense stand of sandbar willows and reed canarygrass. Beaver activity increases.

Poison hemlock is common along the stream.

Site LR-6 Stream Crossing – Bridge **Priority: No Action**

(Little Rocky Creek – Map #1)

Private bridge crossing providing access to the west side of the creek. The steel beam bridge has a 30 foot span and 3 feet of freeboard between the bridge beams and the channel. It sits on the bank without abutments. High water will occasionally flow over and around the bridge causing no apparent damage. A large beaver dam (3 – 4 feet high) plugs the channel 40 feet upstream from the bridge, diverting high flows onto the west floodplain.

Reach 2 **Priority: Medium**

(Little Rocky Creek – Map #1)

Reach Description: Reach 2 is 0.4 miles long, defined by the north and south boundaries of two small tracts on the east side of Little Rocky Creek. Three of the five small tracts (20+ acre size) that border the stream are developed. The creek serves as a property line. Old hay fields border the creek on both sides.

Site LR-6 is located in Reach 2.

Channel Characteristics: The creek is entrenched up to 6 feet deep. High water is causing minor bank erosion on some bends although a dense buffer of willows, reed canarygrass, and smooth brome are impeding most of the erosion.

A series of beaver dams run the length of the reach. The beaver dams are creating backwater conditions that elevate the water table to a level conducive to a healthy, functioning stream.

A house on the east terrace bench is 110 feet from the creek. There is a shallow well, 40 feet of rock rip-rap, and a low-head rock cross-channel weir associated with the house. A house on the west terrace bench is 700 feet from the creek.

A narrow riparian buffer separates Little Rocky Creek from an adjacent hay field.

Riparian Characteristics: The riparian corridor, upstream from Site LR-6, ranges in width from 80 – 350 feet. A narrow buffer 10 – 20 feet wide separates the creek and hay field along the east bank. This buffer is dominated by willows and sod-forming grasses (reed canarygrass and smooth brome). Reed canarygrass may encroach on the channel eventually making it narrower and deeper. Aspen trees are planted along 200 feet of the east bank. Downstream, where the riparian corridor is wider, the landowner has cut access trails through the dense brush.

The riparian corridor downstream from Site LR-6 narrows to about 80 feet. A narrow riparian buffer lines both sides of the creek. A short segment of riparian vegetation has been cleared to accommodate domestic landscaping.

Poison hemlock and houndstongue are common weeds along the creek.

Recommendations:

1) For long-term channel stability, maintain a 40 foot un-mowed riparian buffer between Little Rocky Creek and the hay field and plant locally-harvested willow cuttings along the lower bank.
2) Provide an un-mowed buffer between the landscaped yard and the creek channel.
3) Fence the riparian corridor if horses or livestock are brought in to graze the small tracts.
4) Implement an aggressive weed control program targeting poison hemlock and houndstongue.
5) Allow beaver activity to continue maintaining a healthy riparian corridor.

Reach 3 **Priority: Medium**

(Little Rocky Creek – Map #1)

Reach Description: Reach 3 is 0.4 miles long, defined by the north and south boundaries of two small tracts on the east side of the creek. Five small tracts (20+ acre size) border the stream, two are developed. The creek serves as a property line. Old hay fields border the creek on the east side and native pasture borders the west side.

Channel Characteristics: A series of beaver dams run the length of Reach 3. Beaver dams are creating long backwater pools and maintaining a high water table on the floodplain. Several small open wetlands have been created along the creek.

A house on an east tract is about 600 feet from the creek. On a west tract, a house built on high ground is 30 feet from the creek. Some riparian vegetation was cleared to accommodate landscaping. A thin buffer of riparian vegetation separates the landscaped yard from the creek.

Beaver dam backwater ponding. Dense riparian vegetation along the creek is common.

Riparian Characteristics: The riparian corridor ranges in width from 100 – 200 feet. Along the east bank, a riparian buffer that separates the creek and hay field is over 40 feet wide. This buffer is dominated by willows and sod-forming grasses (reed canarygrass and smooth brome). A riparian fence parallels the creek on the lower end of Reach 3.

Poison hemlock and houndstongue are common along the creek.

Recommendations:

1) Continue managing the creek and floodplain as they are now.
2) Fence the riparian corridor if horses or livestock are brought in to graze the small tracts.

3) For long-term channel stability, re-establish a riparian buffer between Little Rocky Creek and the landscaped grounds on the west bank by planting locally-harvested willow cuttings along the lower bank.
4) Implement an aggressive weed control program targeting poison hemlock and houndstongue.
5) Allow beaver activity to continue maintaining a healthy riparian corridor.

Reach 4 **Priority: Medium**

(Little Rocky Creek – Map #1)

Reach Description: Reach 4 is 0.1 miles long, defined by the north and south boundaries of a small tract on the east side of the creek. Three small undeveloped tracts (20+ acre size) border the stream. The creek serves as a property line. An old hay field borders the creek on the east side; native pasture borders the west side.

Channel Characteristics: A series of beaver dams run the length of the reach. Beaver dams contribute to the flat channel gradient and have created long backwater pools. Most of the low floodplain is flooded by the beaver dams. Short segments of terrace bench along the east side are experiencing minor erosion, but it is not a serious problem.

Minor terrace erosion next to an old hay field on the east side of Little Rocky Creek.

Riparian Characteristics: The riparian corridor ranges in width from 180 – 300 feet and is in excellent condition. A riparian fence runs parallel to the east side of Reach 4.

Poison hemlock and houndstongue are common weeds along the creek.

Recommendations:

1) Continue managing the creek and floodplain as they are now.
2) Implement an aggressive weed control program targeting poison hemlock and houndstongue.
3) Allow beaver activity to continue maintaining a healthy riparian corridor.

Reach 5 **Priority: Medium**

(Little Rocky Creek – Map #1)

Reach Description: Reach 5 is 0.2 miles long, defined by the north and south boundaries of a small tract on the east side of the creek. Three small tracts (20+ acre size) border the creek on both sides; two are developed. The creek serves as a property line. An old hay field/pasture borders the creek on the east side and native pasture borders the west side.

Channel Characteristics: Beaver dams up to 5 feet high are common on the upper half of Reach 5. The beaver dams contribute to the flat gradient, long pools, multiple channels, and a high water table. The low floodplain, flooded by a beaver dam, has several small wetlands. The lower end of Reach 5 transitions into a single-thread, higher gradient channel with a gravel bottom. The lower segment is entrenched about 3 feet into the floodplain. There are a few eroding outside bends on the east side, but none are a significant problem.

Houses along this reach are off-set nearly 800 feet from Little Rocky Creek.

Large beaver dam on the upper end of Reach 5. The dam has elevated the channel grade and water table conducive to a healthy riparian corridor.

Riparian Characteristics: The riparian corridor on upper Reach 5 averages 250 feet wide and gradually narrows to 120 feet on the lower end. A riparian fence runs along part of the east bank. Primary riparian species include sandbar willow and reed canarygrass; smooth brome and snowberry are more dominant on the upper banks.

Poison hemlock and houndstongue are common along the creek.

Recommendations:

1) Continue managing the creek and floodplain as they are now.
2) Fence the complete riparian corridor if horses or livestock are brought in to graze the small tracts.
3) Implement an aggressive weed control program targeting poison hemlock and houndstongue.
4) Allow beaver activity to continue maintaining a healthy riparian corridor.

Reach 6 **Priority: Medium**

(Little Rocky Creek – Map #1)

Reach Description: Reach 6 is 0.2 miles long, defined by the north and south boundaries of a small tract on the east side of Little Rocky Creek. Two undeveloped small tracts (20+ acre size) border the creek on both sides. The creek serves as a property line. An old hay field/pasture borders the creek on the east side and native pasture borders the west side.

Channel Characteristics: The upper half of Reach 6 is a single-threaded channel with a gravel bottom. The creek is entrenched up to 6 feet into the floodplain. Beaver dams are found on the lower half of the reach; some up to 5 feet high. The beaver dams contribute to a flat channel gradient, long pools, and a high water table. There is minor bank erosion on some east side bends, but none are a significant problem.

The upper segment of Reach 6 is a higher gradient, single-thread creek channel with a gravel bottom.

Riparian Characteristics: The riparian corridor varies in width from 30 feet to over 150 feet. A riparian fence parallels the east side of the creek. Primary riparian species include sandbar willow and reed canarygrass with smooth brome and snowberry more common on the higher banks.

Poison hemlock and houndstongue are common along the creek.

Recommendations:

1) Continue managing the creek and floodplain as they are now.
2) Implement an aggressive weed control program targeting poison hemlock and houndstongue.
3) Allow beaver activity to continue maintaining a healthy riparian corridor.

Reach 7 **Priority: Medium**

(Little Rocky Creek – Map #1)

Reach Description: Reach 7 is 0.3 miles long, defined by the north and south boundaries of a single 30 acre tract that follows both sides of the creek. A barn is located 100 feet east of the creek. A hay field borders the creek on the east side and native pasture borders the west side.

Channel Characteristics: A series of beaver dams run the length of the reach. Between the beaver dams and their backwater pools, there are short sections of shallow, gravel-bottom riffles. The

channel is entrenched 6 – 8 feet along most of this reach. Minor bank erosion was noted on a few outside bends along the hay field and farm road. Comparing current day conditions with 1951 aerial photography, little change has occurred over the last 60 years.

Beaver dam and backwater ponding help maintain a dense riparian plant community along the creek.

Riparian Characteristics: The riparian corridor is up to 180 feet wide at the upper end then quickly narrows to less than 60 feet along the remainder of the reach. With the exception of the upper end, the buffer that separates the creek from the hay field is 5 – 30 feet wide. This buffer is primarily smooth brome and snowberry.

Poison hemlock and houndstongue are common along the creek.

Recommendations:

1) Continue managing the creek and floodplain as they are now.
2) For long-term channel stability, maintain a 30 foot un-mowed riparian buffer between Little Rocky Creek and the hay field and plant locally-harvested willow cuttings along the lower bank.
3) Implement an aggressive weed control program that targets poison hemlock and houndstongue.
4) Allow beaver activity to continue maintaining a healthy riparian corridor.

Site LR-7 Stream Crossing – Culvert **Priority: Low**

(Little Rocky Creek – Map #1)

Private culvert crossing (less than two years old) provides landowner access to land parcels on opposites sides of the creek. The crossing is a 6 foot diameter culvert, 15 feet long, that is covered with dirt and pea gravel. Cobble rip-rap has been placed on both the inlet and outlet.

Culvert crossing on lower Little Rocky Creek.

Recommendation: This crossing may cause a channel restriction that is vulnerable to flooding and/or floating debris. Nearly 40% of the channel capacity has been lost. Since the crossing is new, it is unlikely there would be interest in replacing it so soon. But, in the future, when it does need repairs or replacement, constructing a bridge in the same location with a minimum 12 foot span and upper bank abutments (concrete or timber) is suggested.

Reach 8 **Priority: Medium**

(Little Rocky Creek – Map #1)

Reach Description: Reach 8 is 0.1 miles long, defined by the north and south boundaries of a designated park (4.1 acres) for the Spreading Winge Subdivision. The tract boundary crisscrosses a short segment of the creek.

Site LR-7 is located in Reach 8.

Channel Characteristics: The channel is entrenched 4 – 6 feet and is single threaded with a gravel bottom. It has a dense riparian fringe that makes it very stable.

Dense riparian vegetation along the creek channel.

Riparian Characteristics: The riparian corridor ranges in width from 30 – 100 feet and is in excellent condition.

Recommendations:

1) Continue managing the creek and floodplain as they are now.
2) Implement an aggressive weed control program.
3) Allow beaver activity to continue maintaining a healthy riparian corridor.

Reach 9

(Little Rocky Creek – Map #1)

Reach Description: Reach 9 includes the corner of a large pasture that is not part of the Spreading Winge Subdivision. There is a livestock water gap on the upper end of the reach. A small, slow moving landslide along the east boundary of the creek is not causing a problem. Little Rocky Creek enters the Stillwater River at the end of Reach 9.

Channel Characteristics: The channel is less entrenched than Reach 8 because of some large beaver dams.

Little Rocky Creek confluence with the Stillwater River. The edge of the landslide is in the photo foreground.

Riparian Characteristics: The large riparian/wetland "delta area" at the confluence of Little Rocky Creek and the Stillwater River is in excellent condition.

Recommendations: Continue managing the creek and floodplain as they are now.

5. General Recommendations **Priority: High**

1. Bank Stabilization: The Stillwater and West Fork Stillwater Rivers are naturally armored and have few eroding banks. Bank stabilization measures are usually only necessary when buildings or structures are located on the river's edge. The majority of bank stabilization over the last 30 years is associated with small tract developments.

   Installing bank armor can be expensive and is often detrimental to the river. Bank stabilization should only be considered where high value infrastructure (i.e. buildings, bridges, roads) requires protection. A proactive approach to selecting a suitable building site away from the river's edge would eliminate the need for most bank armoring.

   The following are bank stabilization measures that have been used in the Stillwater River Watershed:
   - Rock rip-rap: If bank stabilization is unavoidable, the best option for the Stillwater and West Fork Stillwater Rivers is install well-placed angular rock rip-rap. Sheer stress along their banks is often too high for other types of bank stabilization to last. The exception is straight sections of river where the near-bank shear stress is low. Blanketing the bank with smaller cobbles may suffice.
   - Rock jetties: Rock jetties do not work. Unless incorporated into rock rip-rap, they create more bank instability than they prevent.
   - Bioengineering (root wads, willow lifts, sod mats, etc.): This technique has not been used in the upper Stillwater River. For the Stillwater and West Fork Stillwater Rivers, the high sheer stress and large bedload make bioengineering a high risk. However, bioengineered bank stabilization should be considered on smaller streams where sheer stress is relatively low (i.e. Lodgepole Creek, Limestone Creek, and Little Rocky Creek).

2. Noxious Weed Control: The Stillwater Valley Watershed Group and the Stillwater Weed District are doing an amazing job working with landowners along the upper Stillwater River valley. This successful program should continue encouraging landowners to aggressively control noxious weeds on their property.
   - Spotted knapweed: The spread of spotted knapweed has been curtailed on most of the upper river although small patches and individual plants can still be found. The "search and destroy" program has been successful and should be continued. Target Reach 2 on the West Fork Stillwater River for future control.
   - Leafy spurge: This weed was first seen in the middle section of Reach 4 on the Stillwater River. Infestations became more prevalent towards the lower end of Reach 4 and along the full length of Reach 5.
   - Poison hemlock: This weed has heavily infested Little Rocky Creek. This stream is ideal for poison hemlock as it thrives on sub-irrigated floodplains and pastures. Landowners should be encouraged to work cooperatively on controlling this weed.
   - Houndstongue and Canada thistle: Intermittent patches and individual plants of these noxious weeds were found on all the streams included in this assessment. They are challenging to find and control since they often grow in dense riparian vegetation that is difficult to access. Landowners should be prepared to control these weeds to the extent possible.

3. Small Tracts: The Stillwater and West Fork Stillwater Rivers have multiple subdivisions with small tracts that vary in size from less than 1 acre to 20 acres. Along Stillwater River Reaches 3 and 4, over 50% of the river corridor is subdivided into small tracts. Many of the tracts have houses on or near the river's edge. These developments tend to generate bank stabilization (rock rip-rap, jetties, retaining walls, dikes, etc), in-river pumps for landscape watering, septic systems, riparian clearing, and noxious weed infestations. Individual small tract impacts to rivers are often minimal, but cumulatively they pose a threat to the long-term health of the Stillwater River and its tributaries.

   Develop and implement an outreach and assistance program to help small tract landowners better understand how to minimize their impacts on the river. This program, sponsored by the SVWC, would offer on-site visits by a qualified person to discuss noxious weed management, water rights, septic maintenance, suitable building locations, riparian vegetation, and basic river dynamics.

   Irrigation Diversions: Along Reaches 4 and 5 of the Stillwater River mainstem, there are 14 large irrigation diversions. Nearly all of these diversions have a long wing dike extending upstream from the canal inlet and headgate. It is often necessary to have heavy equipment in the river to repair or replace the wing dike after high water. Continually reconstructing these temporary diversions is expensive and carries long-term impacts to the physical and biological nature of the river.

   The headgate and by-pass structures vary in age and condition. Many by-pass structures are poorly aligned and have too narrow an opening to effectively pass floating debris.

   Each diversion and headgate requires a custom set of options that is determined by the headgate/diversion alignment, structure condition, river pattern, and ditch capacity. Each headgate/diversion site has conceptual recommendations outlined in the report. The options include replacing the temporary wing diversions with more permanent means of diverting and checking the water, often with large rocks and/or portable blocks. At several sites, it is recommended that the by-pass structure be reconstructed or replaced with a larger opening to better accommodate floating debris. For a few headgates/diversion sites, it is recommended that they be replaced and/or relocated to be more functional and compatible with the river.

4. Water Quality Monitoring: Design and implement a water quality monitoring plan for the Stillwater River and major tributaries to determine long-term trends in metal, nutrient, and algal concentrations. An important precursor to implementing a water quality plan is to first compile water quality data and information that is already available. To avoid duplication of efforts, coordinate the monitoring program with the Stillwater Mine and Montana Department of Environmental Quality.

5. Historic Aerial Photography: Georeference the Government Land Office (GLO), 1951, and 1975 imagery to allow for easy viewing and analysis of river trends over the last 110 year period. This imagery provides a valuable tool for landowners and permit managers to better understand past trends and to make more informed river management decisions.

6. References

Montana Department of Environmental Quality (2008). *Clean Water Act Information Center* website at: http://deq.mt.gov/wqinfo/CWAIC/default.mcpx

Montana Department of Fish, Wildlife, and Parks. *Montana Fisheries Information System (MFISH) w*ebsite at: http://fwp.mt.gov/fishing/mFish/

Montana Department of Fish, Wildlife, and Parks. *Montana Fisheries Information System (MFISH) w*ebsite at: http://fwp.mt.gov/fishing/mFish/

Montana Department of Fish, Wildlife, and Parks Stories Success website at: http://fwp.mt.gov/fishAndWildlife/habitat/fish/futureFisheries/success/central.htmlt

Montana Department of Natural Resources and Conservation. *Water Resources Adjudication Information w*ebsite at: http://dnrc.mt.gov/wrd

Montana Office of Public Instruction. Indian Education - *Crow Reservation Timeline Crow Tribe* March 2010 website at: http://opi.mt.gov/pdf/IndianEd/IEFA/CrowTimeline.pdf

Montana Watershed Coordination Council - *Watershed Directory w*ebsite at: http://mtwatersheds.org/Watesheds/WatershedDirectory.html

Natural Resource Information System Montana Geographic Information Clearinghouse website at: http://nris.mt.gov/gis

Parsons, Henry L. *A General Study of Historical Information Relating to Stillwater County,* Winning Essay for the Helen R. Brewer Award, Montana State College, May 16, 1956.

Stillwater Valley Watershed Council (SVWC) website at: http://www.stillwatervalleywatershed.com

US Geological Survey – Montana Flood-Frequency and Basin-Characteristic Data http://waterdata.usgs.gov/mt/nwis/inventory?county

US Geological Survey – Water Resources of Montana website at: http://mt.water.usgs.gov

Appendix A: Stillwater River - Recommended Restoration Priority

Site	River Mile	Bank	Latitude	Longitude	Site Description	Recommended Restoration Priority
SW-1	44.1	-	45.35369	-109.89837	Stream Crossing - Bridge: USFS Woodbine Campground	No Action
SW-2	43.4	L	45.36298	-109.89091	Side Channel Dike	No Action
SW-3	43.1	R	45.36596	-109.88674	Bank Stabilization - Rock Rip Rap	Low
SW-4	42.5	L	45.37327	-109.88146	Pump House - Domestic Use	Low
SW-5	42.1	L	45.37675	-109.87686	Bank Stabilization - Rock rip-rap	No Action
SW-6	41.6	-	45.38148	-109.87144	Cable Crossing - Non Functional	No Action
SW-7	41.5	-	45.38432	-109.87193	Cross-Channel Rock Check Structure	No Action
SW-8	41.4	-	45.38513	-109.87185	Stream Crossing - Private Bridge	No Action
SW-9	41.2	L	45.38702	-109.87323	Discharge Pipe	No Action
SW-10	40.4 - 40.7	L	-	-	Small Tracts - Whited Subdivision	High
SW-11	40.3	-	45.39640	-109.86293	Stream Crossing - Private Bridge	No Action
SW-12	40.1	L	45.39835	-109.86112	Steel Pilings	Medium
SW-13	39.9	L	45.40072	-109.86091	Terrace Erosion	Medium
SW-14	39.9	L	45.40121	-109.85996	Boat Ramp - USFS Old Nye Fishing Access Site	No Action
SW-15	39.2	-	45.40791	-109.85240	Stream Crossing - Private Bridge	No Action
SW-16	38.9	L	45.41063	-109.84958	Bank Stabilization - Rock Rip-Rap	Low
SW-17	38.7	L	45.41264	-109.84676	Bank Stabilization - Rock Rip-Rap	No Action
SW-18	38.6	L	45.41412	-109.84626	Bank Stabilization - Rock Rip-Rap	No Action
SW-19	38.4	L	45.41765	-109.84632	Accelerated Bank Erosion	Medium

Appendix A: Stillwater River - Recommended Restoration Priority

Site	River Mile	Bank	Latitude	Longitude	Site Description	Recommended Restoration Priority
SW-20	38.1	L	45.42108	-109.84407	Bank Stabilization - Rock Rip-Rap	No Action
SW-21	38	R	45.42163	-109.84199	Bank Stabilization - Rock Rip-Rap	No Action
SW-22	37.9	-	45.42226	-109.84195	Stream Crossing- Bridge	No Action
SW-23	37.8	L	45.42327	-109.84175	Bank Stabilization - Rock Rip-Rap	Medium
SW-24	37.7	L	45.42460	-109.84044	Accelerated Bank Erosion	Medium
SW-25	37.1	L	45.42807	-109.83146	Bank Stabilization - Rock Rip-Rap	No Action
SW-26	36.8	-	45.43111	-109.82624	Stream Crossing - Private Bridge	No Action
SW-27	36.5	L	45.43181	-109.81940	Bank Stabilization - Rock Rip-Rap	No Action
SW-28	36.2	R	45.43113	-109.81430	Bank Stabilization - Rock Rip-Rap	No Action
SW-29	36.1	L	45.43182	-109.81268	Bank Stabilization - Rock Rip-Rap	No Action
SW-30	35.9	L	45.43123	-109.80910	Channel Dike	No Action
SW-31	35.7	L	45.43189	-109.80370	Bank Stabilization - Rock Rip-Rap	No Action
SW-32	35.2 - 35.7	L	-	-	Small Tracts - Hanks Cabin Sites and Borland Subdivision	High
SW-33	35.2	-	45.43546	-109.79691	Stream Crossing - Highway 419 Bridge	No Action
SW-34	34.3	L	45.44189	-109.78321	Bank Stabilization - Rock Rip-Rap	No Action
SW-35	32.7 - 34.9	R	-	-	Small Tracts - Buffalo Jump and Spreading Winge Subdivisions	High
SW-36	33.7	L	45.44908	-109.77884	Bank Stabilization - Rock Rip-Rap	No Action
SW-37	33	L	45.45560	-109.76900	Irrigation Pump	No Action
SW-38	32.9	R	45.45542	-109.76656	Bank Stabilization - Rock Rip-Rap/Jetties/Dikes	No Action

Appendix A: Stillwater River - Recommended Restoration Priority

Site	River Mile	Bank	Latitude	Longitude	Site Description	Recommended Restoration Priority
SW-39	32.5	L	45.45556	-109.76229	Bank Stabilization - Rock Rip-Rap	No Action
SW-40	32.3	L	45.45740	-109.76024	Bank Stabilization - Rock Rip-Rap	No Action
SW-41	32.2	L	45.46100	-109.75703	Boat Ramp - Montana FWP Moraine Fishing Access Site	Low
SW-42	32	-	45.46317	-109.75413	Old Stream Crossing Abutments	No Action
SW-43	31.6	-	45.46664	-109.74780	Old Stream Crossing Abutments	No Action
SW-44	31.0 - 31.9	-	-	-	Small Tracts - Tractor and Equipment Subdivision	High
SW-45	31	L	45.47121	-109.74307	Irrigation Structure	No Action
SW-46	30.9	L	45.47096	-109.74132	Boat Ramp - Montana FWP Castle Rock Fishing Access Site	Low
SW-47	30.8	R	45.47301	-109.73884	Irrigation Structure	Medium
SW-48	30	-	45.47783	-109.72741	Stream Crossing - Private Bridge	No Action
SW-49	29.9	R	45.47703	-109.72469	Bank Stabilization - Rock Rip-Rap	No Action
SW-50	29.7	-	45.47771	-109.72017	Stream Crossing - Private Bridge	High
SW-51	29.0 - 29.8	R	-	-	Small Tracts - Foust Subdivision	High
SW-52	29	-	45.48422	-109.71128	Stream Crossing - Private Bridge	No Action
SW-53	29	R	45.48440	-109.71081	Bank Stabilization - Rock Rip-Rap	Low
SW-54	28.8	R	45.48418	-109.70730	Bank Stabilization - Rock Rip-Rap	No Action
SW-55	28.6	L	45.48317	-109.70218	Irrigation Headgate/Diversion - Dyer Ditch	Medium
SW-56	28.3	-	45.48173	-109.69852	Stream Crossing - Private Bridge	Medium
SW-57	28.1	L	45.48122	-109.69486	Bank Stabilization - Rock Rip-Rap/Wall	No Action

Appendix A: Stillwater River - Recommended Restoration Priority

Site	River Mile	Bank	Latitude	Longitude	Site Description	Recommended Restoration Priority
SW-58	27.5 - 27.9	R	-	-	Small Tracts - West Subdivision	High
SW-59	27.5	-	45.48383	-109.68398	Irrigation Flume Supports	No Action
SW-60	27.2	-	45.48837	-109.68145	Stream Crossing - Bridge Abutments/Support	Low
SW-61	26.2 - 27.6	R	-	-	Small Tracts - Midnight Ranch Tracts and North Cabin Sites	High
SW-62	26.6 - 27.2	L	-	-	Small Tracts - Falcon Ridge Subdivision and North Cabin Sites	High
SW-63	26.3	-	45.49285	-109.66761	Stream Crossing - Private Bridge	No Action
SW-64	25.5 - 26.3	L	-	-	Small Tracts - Kratz Subdivision and Other Small Tracts	High
SW-65	25.8	L	45.49470	-109.66196	Rock Retaining Wall/Cable Car	No Action
SW-66	25.0 - 25.6	R	-	-	Small Tracts - Birdhead Ranch Tracts	High
SW-67	25.2	-	45.50088	-109.65635	Stream Crossing - Private Bridge	No Action
SW-68	24.9 - 25.1	L	-	-	Small Tracts - Riddle's Cliff Subdivision	High
SW-69	24.9	-	45.50329	-109.65257	Stream Crossing - County Bridge	No Action
SW-70	24.8	R	45.50373	-109.65243	Irrigation Headgate/Diversion - Stillwater Ditch	High
SW-71	24.3	-	45.50918	-109.64914	Stream Crossing - Private Bridge	No Action
SW-72	24.3	-	45.51059	-109.64215	Inverted Siphon - Stillwater Ditch	No Action
SW-73	23.7	R	45.51069	-109.63755	Bank Stabilization - Rock Rip-Rap	No Action
SW-74	23.4	L	45.51543	-109.63378	Irrigation Flume - Stillwater Ditch	No Action

Appendix A: Stillwater River - Recommended Restoration Priority

Site	River Mile	Bank	Latitude	Longitude	Site Description	Recommended Restoration Priority
SW-75	23.2	R	45.51561	-109.62949	Boat Ramp - Montana FWP Cliff Swallow Fishing Access Site	Low
SW-76	23.1	L	45.51604	-109.62914	Irrigation Diversion - Madison Ditch	No Action
SW-77	21.9	R	45.51967	-109.60450	Irrigation Headgate/Diversion - Yanzick Ditch	High
SW-78	21.9	R	45.52003	-109.60459	Irrigation Headgate/Diversion - Brey-Riddle Ditch	Medium
SW-79	21.1	R	45.52732	-109.59715	Irrigation Headgate/Diversion - Phelps Ditch	Medium
SW-80	20.8	R	45.53089	-109.59497	Irrigation Headgate/Diversion - Larson-Johnson Ditch	High
SW-81	20.1	L	45.53271	-109.58188	Bank Stabilization - Rock Jetty	No Action
SW-82	19.8	-	45.53019	-109.57745	Stream Crossing - County Bridge	No Action
SW-83	19.1 - 19.8	L	45.53056	-109.57142	Corrals/Small Pens/Bank Stabilization - Rock Rip-Rap	Medium
SW-84	18.6	R	45.53264	-109.55266	Bank Stabilization - Rock Rip-Rap	No Action
SW-85	18.5	L	45.53407	-109.55154	Irrigation Headgate/Diversion - Tintinger Ditch	High
SW-86	18	L	45.53528	-109.54127	Bank Stabilization - Rock Rip-Rap	No Action
SW-87	17.7	L	45.53334	-109.53687	Corrals/Water Gap	High
SW-88	17.5	R	45.53407	-109.53346	Bank Stabilization - Rock Rip-Rap	No Action
SW-89	17.3	L	45.53537	-109.53018	Irrigation Headgate/Diversion - Weir-Crawford Ditch	Medium
SW-90	17.3	R	45.53482	-109.53002	Bank Stabilization - Rock Rip-Rap/Jetties/Dikes	No Action
SW-91	17.1	L	45.53359	-109.52679	Bank Stabilization - Rock Rip-Rap/Jetty	No Action

Appendix A: Stillwater River - Recommended Restoration Priority

Site	River Mile	Bank	Latitude	Longitude	Site Description	Recommended Restoration Priority
SW-92	16.9	R	45.53241	-109.52385	Irrigation Headgate/Diversion - Mendenhall Ditch	High
SW-93	16.8	R	45.53294	-109.52065	Bank Stabilization - Rock Rip-Rap	No Action
SW-94	16.3	R	45.53153	-109.51352	Bank Stabilization - Rock Rip-Rap	No Action
SW-95	16.2	L	45.53337	-109.51188	Bank Stabilization - Rock Rip-Rap	No Action
SW-96	16	R	45.53160	-109.50866	Bank Stabilization - Rock Rip-Rap	No Action
SW-97	15.6	R	45.52949	-109.50201	Bank Stabilization - Rock Rip-Rap	No Action
SW-98	15.6	L	45.53071	-109.50140	Irrigation Headgate/Diversion - J. Kern Ditch	High
SW-99	14.9	R	45.52579	-109.48945	Water Control Structure	No Action
SW-100	14.1	R	45.52834	-109.47513	Bank Stabilization - Rock Rip-Rap/Corrals	High
SW-101	14	L	45.53009	-109.47314	Bank Stabilization - Rock Rip-Rap	No Action
SW-102	13.8	L	45.52876	-109.46966	Irrigation Structure/Diversion - Garrigus Ditch	High
SW-103	13.8	-	45.52851	-109.46949	Stream Crossing - Johnson Bridge	No Action
Reach 1	44.1 - 40.3	-	-	-	Sites: SW-1 to SW-11	
Reach 2	40.3 - 36.8	-	-	-	Sites: SW-11 to SW-26	High
Reach 3	36.8 - 30.9	-	-	-	Sites: SW-26 to SW-46	
Reach 4	30.9 - 23.1	-	-	-	Sites: SW-46 to SW-76	
Reach 5	23.1 - 13.8	-	-	-	Sites: SW-76 to SW-103	

Appendix A: West Fork Stillwater River - Recommended Restoration Priority

Site	River Mile	Bank	Latitude	Longitude	Site Description	Recommended Restoration Priority
WF-1	6.2	R	45.44075	-109.90344	Irrigation Headgate - Keogh	No Action
WF-2	5.9	-	45.44192	-109.89737	Stream Crossing - Private Bridge	No Action
WF-3	5.2	-	45.44702	-109.88454	Stream Crossing - Private Bridge	No Action
WF-4	4.2	R	45.45214	-109.86723	Bank Stabilization - Rock Rip-Rap	Low
WF-5	4	-	45.45345	-109.86522	Stream Crossing - Private Bridge	No Action
WF-6	3.2 - 3.7	L	-	-	Small Tracts – Berkley Subdivision	High
WF-7	3.3	R	45.45402	-109.85280	Hillside Slump	High
WF-8	3.2	L	45.45495	-109.84906	Bank Stabilization - Rock Rip-Rap	No Action
WF-9	3	-	45.455509	-109.84654	Stream Crossing - Private Bridge	No Action
WF-10	3	L	45.45550	-109.84507	Irrigation Structure	Medium
WF-11	2.6	R	45.45176	-109.83879	Channel Stabilization - Potential Avulsion	High
WF-12	2.0 - 3.0	L	-	-	Small Tracts – High Chaparral and West Fork Subdivisions	High
WF-13	2	R	45.44972	-109.82791	Irrigation Structure	No Action
WF-14	1.6	L	45.44790	-109.82102	Irrigation Structure - Countryman Ditch	No Action
WF-15	1.5	L	45.44692	-109.8182	Irrigation Structure	No Action
WF-16	1	R	45.44403	-109.81115	Irrigation Structure	No Action
WF-17	1	-	45.44361	-109.80886	Stream Crossing - South County Bridge	No Action
WF-18	1	-	45.44432	-109.80886	Stream Crossing - North County Bridge	No Action
WF-19	0.7 - 0.8	-	-	-	Small Tracts	High

Appendix A: West Fork Stillwater River - Recommended Restoration Priority

Site	River Mile	Bank	Latitude	Longitude	Site Description	Recommended Restoration Priority
WF-20	0.7	L	45.44269	-109.80318	Irrigation Structure	No Action
WF-21	0.5	R	45.44113	-109.80035	Bank Stabilization - Rock Rip-Rap	No Action
Reach 1	6.2 - 3.2	-	-	-	Sites WF-1 to WF-8	
Reach 2	3.2 - 1	-	-	-	Sites WF-8 to WF-21	

Appendix A: Lodgepole Creek - Recommended Restoration Priority

Site	River Mile	Bank	Latitude	Longitude	Site Description	Recommended Restoration Priority
LP-1	4.7	-	45.51383	-109.92548	Stream Crossing - Ford	No Action
LP-2	4.6	L	45.51363	-109.92411	Irrigation Structure	No Action
LP-3	4.3	-	45.51173	-109.91911	Stream Crossing - Ford	No Action
LP-4	4	-	45.50948	-109.91394	Stream Crossing - Ford	High
LP-5	3	-	45.49785	-109.90555	Irrigation Structure	No Action
LP-6	3	-	45.49770	-109.90525	Stream Crossing - Culvert	No Action
LP-7	2.8	-	45.49493	-109.90510	Stream Crossing - Ford	No Action
LP-8	2.7	L	45.49299	-109.90493	Floodplain Dike	No Action
LP-9	2.6	-	45.49201	-109.90489	Stream Crossing - Bridge	No Action
LP-10	2.6	R	45.49176	-109.90470	Floodplain Dike	No Action
LP-11	2.3	-	45.48752	-109.90506	Stream Crossing - Bridge	No Action
LP-12	1.9	R	45.48207	-109.90284	Floodplain Dike	No Action
LP-13	1.9	-	45.48167	-109.90262	Stream Crossing - Ford	No Action
LP-14	1.5	R	45.47725	-109.90125	Corrals	Medium
LP-15	1.5	-	45.47653	-109.90105	Stream Crossing - Culvert	Medium
LP-16	1.2	-	45.47326	-109.90262	Stream Crossing - Bridge	No Action
LP-17	1.1	R	45.47096	-109.90269	Bank Stabilization - Rock Rip-Rap	No Action
LP-18	0.9	R	45.46916	-109.90260	Bank Stabilization - Rock Rip-Rap	No Action
LP-19	0.9	-	45.46874	-109.90235	Stream Crossing - Culvert	Medium

Appendix A: Lodgepole Creek - Recommended Restoration Priority

Reach 1	4.7 - 2.3	-	-	-	Sites LP-1 to LP-11	
Site	**River Mile**	**Bank**	**Latitude**	**Longitude**	**Site Description**	**Recommended Restoration Priority**
Reach 2	2.3 - 0.9	-	-	-	Sites LP-11 to LP-19	

Appendix A: Limestone Creek - Recommended Restoration Priority

Site	River Mile	Bank	Latitude	Longitude	Site Description	Recommended Restoration Priority
LS-1	2.1	R	45.45883	-109.88577	Irrigation Structure	No Action
LS-2	1.9	-	45.45894	-109.88363	Stream Crossing - Bridge	No Action
LS-3	1.7	R	45.45824	-109.87736	Bank Erosion	No Action
LS-4	1.6	-	45.45771	-109.87606	Stream Crossing - Bridge	Low
LS-5	1.6	R	45.45777	-109.87548	Corrals	High
LS-6	1.5	-	45.45788	-109.87497	Stream Crossing - Ford	No Action
LS-7	1.5	R	45.45778	-109.87452	Irrigation Headgate/Check Structure	No Action
LS-8	1	L	45.45948	-109.86483	Hillside Sloughing	No Action
LS-9	0.9	-	45.45890	-109.86224	Stream Crossing - Bridge	No Action
LS-10	0.8	R	45.45849	-109.86086	Irrigation Headgate/Check Structure	Low
LS-11	0.7	-	45.45868	-109.85985	Stream Crossing - Bridge	No Action
LS-12	0.6	R	45.45836	-109.85829	Irrigation Structure	Medium
LS-13	0.1	L	45.45669	-109.84918	Bank Stabilization - Rock Rip-Rap	No Action
LS-14	0.1	-	45.45637	-109.84873	Stream Crossing - Bridge	No Action
LS-15	0	-	45.45519	-109.84750	Stream Crossing - Bridge	No Action
Reach 1	2.1 - 0.9	-	-	-	Sites LS-1 to LS-9	
Reach 2	0.9 - 0	-	-	-	Sites LS-9 to LS-15	

Appendix A: Little Rocky Creek - Recommended Restoration Priority

Site	River Mile	Bank	Latitude	Longitude	Site Description	Recommended Restoration Priority
LR-1	2.3	-	45.33324	-109.76250	Stream Crossing - Bridge	No Action
LR-2	2.2	R	45.43383	-109.76306	Domestic Sump/Pump & Bank Stabilization - Rock Rip-Rap	No Action
LR-3	2.1	-	45.43510	-109.76437	Stream Crossing - Bridge	Low
LR-4	2.1	L	45.43529	-109.76488	Bank Stabilization - Rock Rip-Rap	No Action
LR-5	1.9	-	45.43686	-109.76519	Stream Crossing - Bridge	Medium
LR-6	1.6	-	45.44009	-109.76777	Stream Crossing - Bridge	No Action
LR-7	0.2	-	45.45373	-109.76437	Stream Crossing - Culvert	Low
Reach 1	2.3 - 1.8	-	-	-	-	No Action
Reach 2	1.8 - 1.4	-	-	-	-	Medium
Reach 3	1.4 - 1.0	-	-	-	-	Medium
Reach 4	1.0 - 0.9	-	-	-	-	Medium
Reach 5	0.9 - 0.7	-	-	-	-	Medium
Reach 6	0.7 - 0.5	-	-	-	-	Medium
Reach 7	0.5 - 0.2	-	-	-	-	Medium
Reach 8	0.2 - 0.1	-	-	-	-	Medium
Reach 9	0.1 - 0.0	-	-	-	-	